PAPERS.

CAST IRON EXPERIMENTS.

Ordered, by The House of Commons, *to be Printed,*
30 *July* 1858.

[*Price* 3*s.* 8*d.*]

497.

Under 2 *lbs.* 3 *oz.*

Digitized by the Internet Archive
in 2026

https://archive.org/details/papers-cast-iron-experiments_1858-07-30

64 Parl. Papers
For Reference only

1857/8. XXXVII

CAST IRON EXPERIMENTS.

RETURN to an Address of the Honourable The House of Commons, dated 29 June 1858;—*for*,

"RETURN of any EXPERIMENTS made at the ROYAL ARSENAL on CAST IRON for the Manufacture of CANNON; stating the various Descriptions of Iron received for Testing; the Trials to which they were submitted, whether separately or mixed; and the Results arrived at in each case, so far as they have been hitherto ascertained."

War Office, 29 July 1858.

J. PEEL.

(*Mr. Henry Hussey Vivian.*)

Ordered, by The House of Commons, *to be Printed*, 30 *July* 1858.

BIBL.
LONDIN.
UNIV.

INDEX.

	PAGE.	PLATE.
Prefatory Remarks	2	–
Copy of Letter from Superintendent R. G. Factories to Right Hon. W. Monsell, M. P., suggesting Experiments on Iron	5	–
Copy of Advertisement relative to Experiment	5	–
List of Firms sending Metal, &c. for Testing	6	–
Detail of Experiment	7	–
Explanation of Diagrams	10	–
Ditto - - Tables A. and B.	11	–

LIST OF SAMPLES.

Hæmatite Iron Company	$\frac{11}{1}$	No. 1, Foundry Pig	12	1
	$\frac{11}{2}$	No. 3, Pig Iron	14	2
	$\frac{11}{3}$	No. 4 - ditto	16	3
		Chemical Report	18	–
Messrs. Attwood, Weardale Iron Company.	$\frac{19}{1}$	No. 1, Pig Iron	20	4
	$\frac{19}{2}$	No. 3 - ditto	22	5
	$\frac{19}{3}$	No. 4 - ditto	24	6
	$\frac{19}{4}$	Remelted	26	7
		Chemical Report	28	–
Messrs. Samuelson & Co., South Bank Furnaces.	$\frac{6}{1}$	No. 2, Toughened Pig	30	8
	$\frac{6}{2}$	No. 2, Foundry Pig	32	9
		Chemical Report	34	–
Holdsworth, Bennington, & Byers, Stockton Iron Works.	$\frac{15}{1}$	No. 1, Pig Iron	36	10
	$\frac{15}{2}$	No. 3 - ditto	38	11
		Chemical Report	40	–
Messrs. Needham & Co., Butterley Iron Works.	$\frac{8}{1}$	No. 1, Foundry Pig - Brown Rake	42	12
	$\frac{8}{2}$	No. 2, Pig Iron - Brown Rake	44	13
	$\frac{8}{3}$	No. 3 - ditto - Brown Rake	46	14
	$\frac{8}{4}$	No. 3 - ditto - Blue Rake	48	15
		Chemical Report	50	–

			PAGE.	PLATE.
Messrs. Whitehouse, West Hallam Iron Works.	1/1	No. 1, Foundry Pig	52	16
	1/2	No. 2 - ditto	54	17
	1/3	No. 3 - ditto	56	18
	1/4	Grey Forge	58	19
	1/5	No. 4, Strong Forge	60	20
		Chemical Report	62	–
Goldendale Iron Works	17/1	Pig Iron	64	21
		Chemical Report	66	–
Messrs. Grazebrook, Netherton Iron Works.	2/1	No. 1, Foundry Pig	68	22
	2/2	No. 2, Melting Pig	70	23
	2/3	Grey Forge	72	24
	2/4	No. 4 and 5 Forge	74	25
	2/5	No. 5, Strong Forge	76	26
		Chemical Report	78	–
Messrs. Evers & Martin, Parkhead Furnaces.	10/1	Foundry Melting Pig, C. B.	80	27
	10/2	Grey Forge	82	28
	10/3	Forge Pig	84	29
		Chemical Report	86	–
Messrs. Badger & Co., Old Hill Furnaces, Dudley.	7/1	No. 2, Foundry Pig	88	30
	7/2	No. 3, Grey Forge	90	31
	7/3	No. 4, Forge	92	32
	7/4	Strong Forge	94	33
		Chemical Report	96	–
Messrs. Firmstone & Co., Lays Iron Works.	16/1	Hæmatite Iron, 1st melting	98	34
		Chemical Report	100	–
Lord Ward's Level Iron Works.	12/1	H. B. Pig Iron	102	35
	12/2	C. B. Pig Iron	104	36
		Chemical Report	106	–
Messrs. Butlin & Co., East End Iron Works.	9/1	No. 1, Grey Foundry Pig, C. B.	108	37
	9/2	No. 2, Mottled Iron	110	38
		Chemical Report	112	–
Messrs. Judkins, Heyford Iron Works.	18/1	Pig Iron, 1st melting	114	39
		Chemical Report	116	–

			PAGE.	PLATE.
Forest of Dean Company, Park End Iron Works.	$\frac{4}{1}$	No. 1, Foundry Pig - - - -	118	40
	$\frac{4}{2}$	Grey Forge - - - - -	120	41
		Chemical Report - - - -	122	–
Mr. Palmer Budd, Ystalyfera Iron Works.	$\frac{3}{1}$	No. 1 Foundry, 2d melting - - -	124	42
	$\frac{3}{2}$	No. 2 - - ditto - - - -	126	43
	$\frac{3}{3}$	No. 3 - - ditto - - - -	128	44
	$\frac{3}{4}$	No. 1 Foundry, 1st melting - - -	130	45
	$\frac{3}{5}$	No. 2 - - ditto - - - -	132	46
	$\frac{3}{6}$	No. 3 - - ditto - - - -	134	47
		Chemical Report - - - -	136	–
Messrs. Thomas, Blaenavon Iron Works.	$\frac{14}{1}$	No. 1 and C. Forge - - - -	138	48
	$\frac{14}{2}$	No. 1, C. B. - - - - -	140	49
	$\frac{14}{3}$	Common Forge, C. - - - -	142	50
	$\frac{14}{4}$	No. 3, C. B. - - - - -	144	51
	$\frac{14}{5}$	Bright Forge, B. - - - -	146	52
		Chemical Report - - - -	148	–
Messrs. Firmstone, Pontypool Iron Works.	$\frac{13}{1}$	C. B. Pig Iron - - - - -	150	53
		Chemical Report - - - -	152	–
Tables showing the various Qualities of Iron, arranged in order of Strength			A. - 154	–
			B. - 156	–
Remarks explanatory of the course adopted in the Chemical Examination of the Iron Samples, and of the Materials employed in their manufacture - - -			157	–

DESCRIPTION of the Analytical Processes employed in the Chemical Examination of the Irons, Ores, Fuels, and Fluxes.

Analysis of Iron - - - - - - - - - - - - - -	158	–
„ Iron Ores - - - - - - - - - - - - -	160	–
„ Fluxes - - - - - - - - - - - - - -	160	–
„ Fuel - - - - - - - - - - - - - -	160	–
Results of the Chemical Examination of Iron, and Materials employed in its production - - - - - - - - - - - - - -	161	–

TABULATED STATEMENTS of the important Per-centage Results obtained in the Examination of Samples.

Table I.—Pig Iron - - - - - - - - - - - -	163	–
II.—Iron Ore - - - - - - - - - - - -	164	–
III.—Flux and Fuel - - - - - - - - - - - -	165	–

APPENDIX.

Messrs. Begbie - - - -	$\frac{22}{1}$	Swedish Grey, Pig Iron - - -	168	54
Messrs. Sweetland, Acadian Charcoal Iron Company.	$\frac{23}{1}$	Nova Scotia Pig Iron - - - -	170	55
	$\frac{23}{2}$	- - - Ditto - - (White) - -	172	56

			PAGE.	PLATE.
Messrs. Townsend, New York.	21/1	Sterling Pig Iron - - - - -	174	57
Messrs. Cooper, Indian Iron Company.	20/1	Charcoal Pig Iron - - - - -	176	58
Elba Iron Company - - - -		Elba Iron - - - - - - -	178	–
Tuscan Iron Company - - -		Tuscan Iron - - - - - -	178	–
Low's Patent Iron - - -	5/1	- - - - - - - - - -	180	59
		Chemical Report - - - -	182	–
Price & Nicholson's Patent Iron - - - - - - - - - - -			184	60
Ulverstone Iron - - - - - - - - - - - - - -			186	–
Bowling Iron - - - - - - - - - - - - - - -			186	–
Table of Qualities - - - - - - - - - - - - - -			188	–
Chemical Report on Iron, and the Materials employed in its manufacture, at the Beeston Manor Iron Works, near Leeds - - - - - - - - - -			189	–
Remarks on the Appendix Table of Chemical Analysis - - - - - -			191	–
Table of Results obtained by the Chemical Examination of Samples of Foreign Iron, and of Pig Iron, representing supplies principally from the sources included in the Report - - - - - - - - - - - - - -			193	–
Chemical Report on Irons treated by Patent processes - - - - -			193	–

ERRATA.

Page 14—second line—*for* No. 2, *read* No. 3.

124-134—first line—*for* Messrs. Palmer and Budd, *read* Mr. Palmer Budd.

REPORT relative to a Series of MECHANICAL EXPERIMENTS made under the direction of the Superintendent Royal Gun Factories, and of Chemical Analyses under the Chemist to the War Department, upon various BRITISH IRONS, ORES, &c., with a view to an Acquaintance, as far as possible, with the most suitable varieties for the MANUFACTURE of CAST IRON ORDNANCE; with an APPENDIX, containing similar Examinations of several FOREIGN and other IRONS, carried on by order of the Secretary of State for War, dated 9 June 1856 $^{273-10}_{6}$.

REPORT relative to a Series of MECHANICAL EXPERIMENTS made under the direction of the Superintendent Royal Gun Factories, and of Chemical Analyses under the Chemist to the War Department, upon various BRITISH IRONS, ORES, &c., with a view to an Acquaintance, as far as possible, with the most suitable Varieties for the MANUFACTURE of CAST IRON ORDNANCE; with an APPENDIX, containing similar Examinations of several FOREIGN and other IRONS, carried on by order of the Secretary of State for War, dated 9 June 1856 $\frac{273-10}{6}$.

MECHANICAL EXPERIMENTS.

THE following experiments, of an extensive and laborious character, have been carried on under the superintendence of Colonel F. Eardley Wilmot, R. A., Superintendent Royal Gun Factories.

The specimens have all been tested by Mr. M'Kinlay (the proofmaster) and his assistants, who conducted the trials.

The specimens were roughly prepared in the factory, and accurately finished by Robert M'Kenzie.

The specific gravities were taken by George Simm.

The computations are by Robert Smith, computer.

The accompanying letter, addressed to the Right Honourable William Monsell, M. P., will explain the reasons which led to the investigation and inquiry now reported on.

The subject is one of considerable interest and difficulty; and the publication of the results will, it is hoped, be examined by many of those able men, whose writings on subjects of cast iron, and the strength of materials generally, are well known.

The term "cast iron," as describing any specific material, does not convey to the mind of those connected with such experiments any more positive quality than what may be gathered from the use of the term "wood" in speaking of that material. The remarkable range of the various qualities of different samples is scarcely more marked in the latter than in the former; and, in addition, the same iron treated in a different manner, as regards the apparently simple process of melting or cooling, assumes a different character.

The general result of a considerable number of such experiments is shown in the following Table:—

TABLE showing the comparative Qualities of CAST IRON; also the Ratio of their Strength (deduced from the general mean) as shown by the different Tests.

	Specific Gravity of 850 Specimens.	Tensile of 850 Specimens.	Transverse of 564 Specimens.	Torsion of 276 Specimens.	Crushing of 273 Specimens.
Maximum	$\frac{14}{3}$ 7·340	$\frac{1}{3}$ 34,279	$\frac{16}{1}$ 11,321	$\frac{1}{3}$ * 9,773	$\frac{14}{3}$ 140,056
Minimum	$\frac{18}{1}$ 6·822	$\frac{18}{1}$ 9,417	$\frac{18}{1}$ 2,586	$\frac{18}{1}$ 3,705	$\frac{11}{1}$ 44,563
General mean	Of 51 Samples. 7·140	Of 51 Samples. 23,257	Of 53 Samples. 7,102	Of 51 Samples. 6,056	Of 51 Samples. 91,061
Ratio in terms of the Tensile		1·000	·305	·260	3·915
Ditto Transverse		3·274	1·000	·852	12·821
Ditto Torsion		3·840	1·172	1·000	15·053.
Ditto Crushing		·255	·078	·066	1·000

* The small figures $\left(\text{as}\frac{1}{3}\right)$ refer to the samples in the subsequent Tables.

There

There has been in the present instance no intention of ascertaining any data relative to the most suitable mixtures of various brands of iron, nor of making experiments as to the treatment of any particular iron with reference to improving its quality, but simply to ascertain that quality as purchasable in the market, or when specially supplied, as suitable for the particular purpose. The iron has all, therefore, been treated in a precisely similar manner, and with few exceptions in the same furnace, which was kept free for the purpose. The pigs were broken, and where a variety of appearance was found, turnings of each were mingled together, and examined as a mean sample for analysis.

And here we are at once met by questions which indicate the magnitude of this inquiry, if carried to its full extent. Does not almost every variety of iron require some treatment peculiar to itself? and to effect an object with any particular iron, must there not be a definite dimension suitable to that iron? It is thought that it is so; and that in a gun, for instance, the form and dimensions offering the greatest strength with one iron, are not those best suited to another.

The results already obtained by various experiments on the subject of remelting cast iron are well known, and have been repeated at various times in this department; when, however, the experiment is made with large masses of iron of several tons, the effect produced is not so marked. It would appear that without any considerable diminution of the impurities in the metal, as silicon, sulphur, and phosphorus, a considerable increase of tenacity and specific gravity can be obtained. The graphite is partially expelled, and some of it is converted into combined carbon, and the contraction and crystallization is more energetic and complete. This combined carbon can, it is thought by some, on again remelting the mass, and very slowly cooling it, be re-converted to graphite, rendering the iron soft and fusible. This is undoubtedly the case with the product of the refinery process, known as "Metal," the use of which, on this principle, formed the subject of a patent, by Dr. Price, in 1856.

There is a point not, probably, accurately determined, at which the maximum hardness corresponding to the maximum tenacity may be found. In an iron cannon there is, however, required an elasticity in addition to other qualities, when these qualities are not in excess to such an extraordinary degree as to render the mass so strong and rigid as to obviate any danger of disruption. It has been found in the various experiments made at Woolwich, that in most cases where the specific gravity is 7·3 or upwards, the metal is unsuited for gun purposes, on account of its hardness and want of elasticity; while the same iron, treated in the furnace for a shorter time, and being, when cast, of a lower specific gravity and less tenacity, would have resisted more satisfactorily the explosion of the powder.

In the case of a cylindrical round bar 26 feet long and 7 inches diameter, cast vertically, the following specimens were taken. The mixture is similar to that used at the time for making guns, and was melted in a single furnace charged with 33 cwt. 2 qrs., and occupied 2 hours 15 minutes in melting.

Two discs in immediate contact with one another, each furnishing two tensile specimens, were cut off from the top, the bottom, and the centre, *i. e.* at intervals of 11 feet 11 inches asunder.

	TENSILE.	SPECIFIC GRAVITY.		TENSILE.	SPECIFIC GRAVITY.
Top - - -	29,382	7·251	Bottom - -	26,594	7·325
„ - - -	27,872		„ - -	27,122	
„ - - -	31,266	7·183	„ - -	29,985	7·323
„ - - -	30,587		„ - -	30,889	
Centre - -	29,231	7·251	Combined Mean:		
„ - - -	26,218		Top - -	29,778	7·217
„ - - -	27,499	7·325	Centre -	27,650	7·263
„ - - -	27,649		Bottom -	28,648	7·324

The effect of the fluid pressure as regards the density of the metal is sufficiently well marked, but the tenacity is not increased.

It would require a longer series of experiments than we have had time to institute, to establish accurately the relation between the amount of fluid pressure, and the resulting tenacity and density. The result here given would appear to be in conformity with the opinion that increasing the length of the dead-head does not add to the resisting power of the metal when used for a gun, all that is required being to afford an ample allowance for feeding in shrinking, in consequence of the strength not being due to pressure or condensation, but to the contraction and crystallization of the mass. In bronze or brass gun metal, the material being of a compressible character, a very decided result is obtained, as is shown in the following experiment upon specimens cut from the base, the muzzle, and the dead-head of a six-pounder brass gun, having about 30 inches in vertical depth between each :—

	SPECIFIC GRAVITY.	TENSILE.
		Lbs.
Top - - - - - -	8·539	35,600
Centre - - - - - -	8·545	38,704
Bottom - - - - - -	8·814	49,401

The most decided features to be observed in the results are the universal and very marked superiority of the bars in the cases where they have been cast horizontally, over those cast vertically; and the superiority, but in a less marked degree, of the bars cooled quickly over those cooled gradually or slowly. It is to this rapid cooling and condensation that the superior strength of a two-inch bar, cast from a portion of the metal of which a gun is made, is due.

This is almost universally found to be the case in the experiments hitherto made with a portion of metal taken from the dead-head, close to the muzzle of the gun, as compared with the bar cast at the time of making the gun.

The contrast, as regards appearance, is equally marked. In the bar, a close, grey, rigid appearance ; in the dead-head, a large grain with graphitic masses joined or cemented together with a whiter and harder material.

Certain supplies ordered on the results hereafter given have, on examination, given results differing much, both chemically and mechanically, showing superiority in some cases, and inferiority of a very marked character in others.

The demand for the manufacture of iron ordnance, and the necessity for the supply of a certain number to meet what is expected in this country, of a new Government establishment, has prevented such various experiments being made as are desirable. At a new Government foundry on the Continent, established about the same time, two years were allowed for experiments before a "supply" was demanded. It would appear that a great deal is still to be done on this subject, and that we are only now at the commencement of vast improvements in the manufacture of cast iron and cast steel. Some very fine results have been obtained from cast material prepared by Mr. Bessemer, which promise well; and, generally, the attention of those connected with the manufacture and use of iron is being directed to the subject. It cannot be too strongly urged that the possession of a machine such as that in use in the Royal Gun Factories would greatly assist inquiries. A drawing of it is given in the United States "Reports of Experiments on Metals for Cannon," Trubner & Co., Paternoster-row ; and the use

use of it, with several additions, can be seen at the Arsenal. The manufacture of similar, or improved machines, and the distribution of them through the country, would be attended with great results.

The Superintendent Royal Gun Factories to the Right Hon. *W. Monsell*, M. P., relative to a Series of Experiments with Cast Iron.

Sir, Woolwich, 5 June 1856.

I BEG to call attention to the desirableness of enlarging the series of experiments as to the best quality of iron for cannon The question is one of great importance as regards the public service, and the improvement of an important branch of British industry.

A true and valuable result can only be arrived at by the possession of satisfactory data; we are now in a position to make the necessary experiments.

The cost of procuring the sample of iron as proposed in the accompanying advertisement, will be small compared with the magnitude and value of the results, in a national point of view. I beg to suggest, that the enclosed advertisement be put in the public papers herein detailed, and that the replies and communications be forwarded to me when received.

By this means Her Majesty's Government will furnish for their own use, and for the nation, a series of data of the highest value and importance.

Yours, &c.

(signed) *F. Eardley-Wilmot*,
Lieut.-Col. Royal Artillery,
Supt. Royal Gun Factories.

Right Hon. W. Monsell, M. P.

The following Advertisement, as issued by the War Department, appeared in the Public Prints, dated 9 June 1856.

IT being desirable that Her Majesty's Government be in a position to procure cast iron of the quality suited to the various purposes to which it is applied in the service, a series of experiments, already commenced, will be made with every variety of strong iron that can be procured, the product of the United Kingdom.

These inquiries will comprise chemical analyses; specific gravity; mechanical properties, as shown by tenacity; torsion; transverse strain; compressibility; impact; rending, and elasticity. The experiments will be tabulated and published.

Ironmasters wishing to submit their produce to the above investigation are requested to communicate to the "Principal Clerk, War Department, Pall Mall," before 30th June 1856, the terms on which they are willing to deliver at the Royal Gun Factories, Woolwich Arsenal, samples of not less than five cwt. of pig iron, with a small quantity of the fuel, flux, and ore employed. A certified statement to accompany the samples, giving all particulars, and specifying that the sample of iron is of the first or second melting, as the case may be; also, that the samples have been taken at random, and that similar iron can be produced in quantity. None that has been melted more than twice will be received.

In answer to the foregoing advertisement, the undermentioned firms delivered at the Royal Gun Factories, Woolwich, samples of iron, ore, flux, and fuel.

		Number of Samples.
1st.	Messrs. Whitehouse, West Hallam, Ilkeston - - -	5
2d.	Messrs. Grazebrook, Netherton Iron Works, near Dudley -	5
3d.	Mr. Palmer Budd, Ystalyfera Iron Works, Swansea - -	6
4th.	Forest of Dean Company, Park End Works, Gloucestershire	2
5th.	Messrs. Lewsey, 7, Albion-terrace, Commercial-road, St. George's - - - - - - - - - - -	1
6th.	Messrs. Samuelson & Co., South Bank Furnaces, Middlesbrough - - - - - - - - - -	2
7th.	Messrs. Badger & Co., Old Hill Furnaces, near Dudley -	4
8th.	Messrs. Needham & Co., Butterley Iron Works, near Alfreton, Derbyshire - - - - - - - - -	4
9th.	Messrs. Butlin & Co., Wellingborough, Northamptonshire	2
10th.	Messrs. Evers & Martin, Park Head Furnaces, near Dudley	3
11th.	Hæmatite Iron Works, Whitehaven, Cumberland - -	3
12th.	Lord Ward's Level Iron Works, Brierley Hill - - -	2
13th.	Pontypool Iron Company, Works, near Dudley - -	1
14th.	Messrs. Thomas, Blaenavon Iron Works - - - -	5
15th.	Messrs. Holdsworth, Bennington & Byers, Stockton-on-Tees	2
16th.	Messrs. Firmstone, Lays Iron Works, near Dudley - -	1
17th.	Messrs. Williamson, Goldendale Iron Works - - -	1
18th.	Messrs. Judkins, Heyford Iron Works, near Weedon -	1
19th.	Messrs. Attwood, Weardale Iron Company, Darlington -	4
20th.	Messrs. Cooper, Indian Iron Company (stock in Royal Gun Factory) - - - - - - - - - -	1
21st.	Messrs. Townsend, New York (stock in Royal Gun Factory)	1
22d.	Messrs. Begbie, Swedish - - - ditto - -	1
23d.	Acadian Iron Company, Nova Scotia - ditto - -	2

Note.—The marks used to distinguish the various metals indicate the firms, and quality of the samples; thus, $\frac{8}{3}$ signifies No. 3 iron, of the eighth firm (Butterley Company), shown in the second column of the Tables.

Manufacture.

Under the above heading, all the information sent by the different firms has been inserted. In a few cases, no description of the manufacture of the metal, or of the kinds of ore and fluxes used, have been received.

The reports are arranged in the order of the districts producing the iron and minerals; viz.:—

Northern.
North Midland.
North Staffordshire.
South Staffordshire.
Northamptonshire.
Forest of Dean.
South Wales.

The foreign irons are placed in an Appendix, with other varieties.

Casting.

To carry out this important part of the experiment, it was necessary that all the samples should be treated as nearly as possible in the same manner.

To effect this, an air furnace, of the ordinary reverbatory kind, was built and exclusively retained for this particular purpose. Previous to each day's casting, a charge of 5 cwt. of Gartsherrie iron was melted, tapped out, and the bottom of the furnace cleared of any cinder or scoria, before the *first* experimental charge was put in, thus insuring the furnace being about the same temperature at the time of charging with each sample.

The coal used was "selected best West Hartley."

The furnace being tapped, the metal was run continuously into the ladles, and directly poured into the moulds.

The castings consisted of 18 bars, each 22 inches long and two inches square; nine were cast in moulds laid horizontally; nine in moulds vertically.

To determine the effects of cooling, the following rule was observed throughout the experiment.

Six bars were covered with sand to delay cooling as much as possible, and kept in the mould until thoroughly cold before being turned out. *Slow.*

Six bars cast in the usual way. *Gradual.*

Six bars were turned out of the mould as soon as set, and left to cool, being exposed to currents of air. *Quick.*

This treatment was common to all bars, both horizontally and vertically cast.

The weight of iron and waste, the consumption of coals, with the time of melting and cooling, are given in the top division of each set of tables.

Mechanical Testing.

The machine used in this operation principally consists of two levers combined together, so as to produce a power of 200 to 1, having shackles, nippers, &c. for attaching the specimens for the different tests; and indices for measuring the amount of extension or deflection in the various processes; a self-acting register also indicates the amount of extension or deflection at the time of breaking.

The temperature of the room was kept as uniform as circumstances permitted, and the time of each sample being under trial, was as nearly identical as possible.

The bars for testing were distributed as follows, viz.,

		Horizontal.	Vertical.
Transverse	Slow	2	2
	Gradual	2	2
	Quick	2	2
Torsion	Slow	1	1
	Gradual	1	1
	Quick	1	1

After the bars were tested in the above manner a tensile specimen was taken from each, and also a small cylinder for specific gravity.

From the torsion bars, specimens were taken, and afterwards tested by the crushing force.

Each specimen is stamped with a register number referring to the Record-book, wherein the whole of the experiments are detailed.

Transverse Strength.

The bars previous to being broken were ground in the centre, so as to present a regular surface; this being necessary for obtaining a correct measure of the fracture, and to prevent the rapid destruction of the measuring callipers on the rough surfaces.

When the strain of 5,000 lbs. had been gradually applied, the deflection was noted, the weights removed, and the permanent set measured; this was repeated after each additional 5,000 lbs. until fracture took place, when the deflection at the time of breaking, shown by the self-registering indicator, was recorded.

In measuring the fracture three dimensions are taken, viz., at the centre and the two corners; the mean of these determines the breadth; the depth is taken in like manner.

The differences in the cross sections of bars are shown in figures in the column headed B D^2.

By the following formula the unit of comparison (S) is obtained:

$$S = \frac{L\,W}{4\,B\,D^2}$$

L = Length between bearings. W = Breaking weight.

B = Breadth of bar. D = Depth.

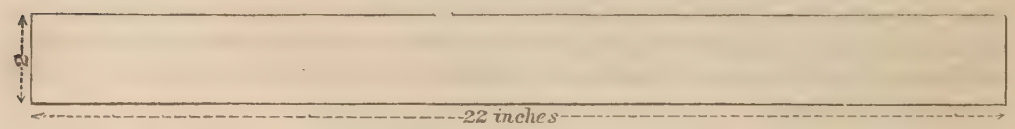
The reduced number represents the strain necessary to break a bar of the same metal one inch square, projecting horizontally one inch beyond the point of support, the weight being applied at the outer end.

The bars so treated had each a cylinder turned for tensile testing, also a small cylinder for specific gravity taken from one end; in the case of the vertically cast bars the lower end was selected; in the horizontal, the end farthest from the runner was used.

The horizontally cast bars were invariably placed in the machine, in such a manner, that the upper surface of the casting was subjected to the compressing force while under trial.

In the case of vertically cast bars the most porous side was similarly placed in order to get the highest results possible.

Bar for Transverse Testing.

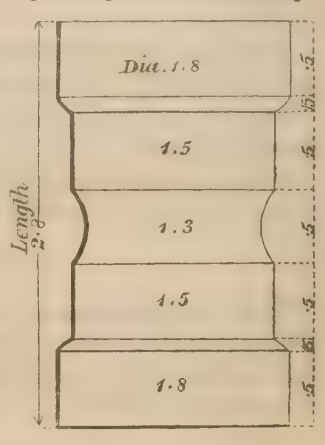


Sketch of Broken Bar.

Tensile Strain.

The cylinders used in this test are of the form and dimensions shown in the margin.

Cylinder for Tensile Testing.



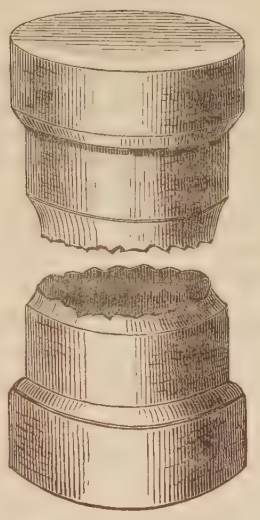
The projections at the ends are for fastening the specimen in the nippers of the machine. The strain is applied perpendicularly, and the specimen pulled asunder, generally at the *line of breakage* (the smallest part), which has been accurately gauged before being tested. This area, with the amount of force actually applied to break the specimen, constitute the data, from which the force required to break a similar bar, one inch square, is calculated by the following formula:

$$S = \frac{W}{A}.$$

W = Breaking weight.

A = Area in inches.

Sketch of Broken Cylinder.



The *extension of the specimen* under the different pressures, commencing at 15,000 lbs., was noted, and at every 5,000 lbs. additional; also, the extension at the time of breaking, as indicated by the self-registering indicator before mentioned.

This extension can only be considered as *comparative*, the irregular form and the size of specimen being unsuitable for actual measurement; also, the extensions given are partly due to the compression of the head, and partly to the elongation of the body of the specimen.

Torsion.

The specimens used in this mode of testing are cylindrical in the centre and square at the ends, for the purpose of making the bars fast; one end of the bar is keyed to the standing part of the machine, the other to the moveable levers.

The *angle of torsion* was observed at 1,000 lbs. pressure, and on the addition of every 500 lbs. afterwards.

To determine the *permanent set* the strain was removed, and the angular set obtained.

After breaking, the *angular fracture* in degrees, measured from the base, and the length of the fracture in calibres of the bar, were then recorded.

The formula for reducing the strain per square inch is as follows:

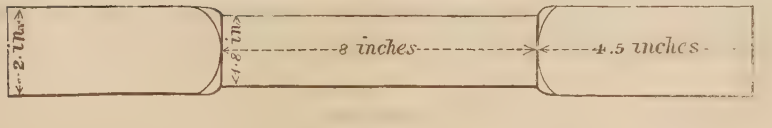
$$\frac{R\,W}{d^3}$$

R = Radius.

W = Weight.

d = Diameter of bar.

Bar for Torsional Testing.



Sketch of Bar, broken.

Crushing.

The specimens used in this operation are small cylinders (·6 diameter, 1·3 in height), taken from the bars used for torsional strain; the *depression* of the specimen when under 15,000 lbs. pressure was noted, the weights removed, and the amount of *permanent set* taken. This was repeated at every 5,000 lbs. additional until rupture took place, or the specimen ceased to offer resistance to the pressure; the *restoration* is the difference between the compression of the specimen with the weights on the scale, and the permanent set with the weights removed.

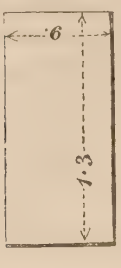
The formula for reducing the resisting force per square inch, is as follows:—

$$S = \frac{W}{A}.$$

W = Weight in lbs.

A = Area of end of cylinder.

Cylinder for Crushing.



Sketch of Cylinders after Crushing.

Deficient and Unsound Specimens.

In several samples the entire set is deficient of one or more specimens, occasioned by an insufficiency of metal, arising in some cases from an extra amount of slag or waste—imperfect casts—the distinguishing mark being obliterated or of doubtful character, in which case the specimen was rejected.

Some of the samples were too hard to turn into tensile or torsion specimens; the transverse is the only test these were subjected to.

In many cases the specimens were more or less defective, a circumstance not known or suspected before breaking; the mark * indicates specimens of this description. The influence these defects exert on the mechanical test, can better be known by comparison with sound specimens than by any verbal description of their appearance, &c., which has not been attempted.

When any great difference is found in the specific gravity of specimens from the same sample of iron, it may fairly be assumed that they are defective, although apparently sound judged by outside appearance.

Diagrams.

These are only intended to give a general idea of the connexion between the different modes of testing, and to illustrate the effects of different states of casting and cooling. The numbers from which the figures are traced are taken from the table of "mean" results.

Three scales are used, viz., one for specific gravity; one for tensile, transverse and torsion; and another for crushing. This arrangement is necessary to show the comparative values of each, in a size suitable for the work.

The results from bars cast horizontally are shown in thin lines, those cast vertically by thick ones.

Table (A.)

Contains an abstract of the different modes of testing detailed in the separate sheets; also the samples, arranged in the order of quality.

It is not intended that this arrangement should be used indiscriminately for comparing one sample of iron with another, the different kinds being classed according to their strength, irrespective of their grade or quality.

Table (B.)

This Table is quite of a general character, and is formed by taking the mean results of all bars cast horizontally, and comparing them with those cast vertically, the figure 1 being used to designate those in excess; in like manner the different results by cooling are recorded.

It may be remarked, that when the results are nearly of the same kind as in the case of horizontally and vertically cast torsion bars, little reliance can be attached, the ratio in this case being nearly the same, or 27 : 24; but in the transverse, tensile, specific gravity, and crushing, the differences are so decided as to lead to the conclusion, that some influence has been exerted to render the horizontally cast bars, stronger than those cast vertically.

TABLES

SHOWING THE

RESULTS OF EXPERIMENTS

ON

BRITISH IRON

FOR THE

MANUFACTURE OF CAST IRON ORDNANCE.

HÆMATITE IRON COMPANY,

No. 1.—

MANUFACTURE.

Foundry Pig Iron manufactured from pure red Hæmatite Ore.

Cast - - - 4 October 1856.
Barometer - - - 29·69
Thermometer - - - 67·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge - - -	4	3	19
Castings - - -	3	3	22
Runners - - -	0	1	14
Slag and waste -	0	2	20
Coals consumed -	4	0	20

Time of—	hrs.	min.
Melting - - -	1	5
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1504			1	7·082	1·3	·004	–	–	–	–	–	–	·010	16,000	12,054
1505	Mark $\frac{11}{1}$.	Slow -	2	7·086	1·3	·003	–	–	–	–	–	–	·011	16,500	12,430
1506			3	7·059	1·3	·005	–	–	–	–	–	–	·011	17,000	12,807
	CAST.														
1507	4 October 1856.		1	7·104	1·298	·004	–	–	–	–	–	–	·014	18,600	14,056
1508		Horizontal. Gradual	2	7·087	1·3	·003	–	–	–	–	–	–	·013	18,900	14,239
1509	TESTED.		3	7·080	1·299	·002	–	–	–	–	–	–	·011	18,000	13,582
	Tensile, 10 Oct 1857.														
1510	Temp. 59°.		1	7·086	1·283	·003	–	–	–	–	–	–	·018	17,200	13,304
1511		Quick -	2	7·096	1·3	·003	–	–	–	–	–	–	·010	17,600	13,259
1512	Transverse, 21 Aug. 1857. Temp. 72°.		3	7·089	1·3	·002	–	–	–	–	–	–	·005	16,200	12,205
1513	Torsion, 14 Oct. 1857. Temp. 60°.		1	7·097	1·3	·003	–	–	–	–	–	–	·014	18,800	14,164
1514		Slow -	2	7·103	1·3	·003	·010	–	–	–	–	–	·012	20,900	15,745
1515	Crushing, 25 Jan. 1859. Temp. 55°.		3	7·103	1·3	·001	·005	–	–	–	–	–	·008	21,800	16,424
1516			1	7·115	1·296	·003	·008	–	–	–	–	–	·012	20,900	15,843
1517	FRACTURE.	Vertical. Gradual	2	7·119	1·294	·001	·005	–	–	–	–	–	·011	21,500	16,348
1518	Medium Grey Bluish. Lustrous. Regular.		3	7·107	1·3	·003	–	–	–	–	–	–	·015	18,500	13,938
1519	Medium Grain.		1	7·109	1·3	·003	–	–	–	–	–	–	·011	19,500	14,691
1520	Good and soft working.	Quick -	2	7·121	1·3	·003	·008	–	–	–	–	–	·012	22,300	16,800
1521			3	7·107	1·3	·002	–	–	–	–	–	–	·011	19,000	14,314
	GENERAL MEAN - - -			7·097	1·298	·003	·007	–	–	–	–	–	·011	18,844	14,233

TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
2·00	1·99	7·9202	·108	·015	–	–	–	–	·164	6,500	4,103
2·00	1·99	7·9202	·109	·013	–	–	–	–	·200	7,300	4,608
–	–	–	–	–	–	–	–	–	–	–	–
2·00	2·01	8·0802	·099	·009	–	–	–	–	·172	7,300	4,517
2·02	2·01	8·1610	·096	·008	–	–	–	–	·187	7,900	4,840
–	–	–	–	–	–	–	–	–	–	–	–
1·93	2·02	7·8751	·106	·010	–	–	–	–	·182	7,700*	4,888*
2·02	1·96	7·7600	·103	·018	–	–	–	–	·165	6,900	4,445
–	–	–	–	–	–	–	–	–	–	–	–
1·98	1·98	7·7623	·095	·009	–	–	–	–	·150	6,900	4,444
2·01	1·98	7·8800	·094	·008	–	–	–	–	·143	6,500	4,124
–	–	–	–	–	–	–	–	–	–	–	–
1·97	1·96	7·5679	·095	·009	–	–	–	–	·124	6,000	3,964
1·97	1·96	7·5679	·092	·007	–	–	–	–	·162	7,400	4,889
–	–	–	–	–	–	–	–	–	–	–	–
1·96	1·97	7·6065	·094	·007	–	–	–	–	·123	6,000	3,943
1·98	2·02	8·0791	·054	·009	·105	·019	–	–	·163	11,250	6,962
–	–	–	–	–	–	–	–	–	–	–	–
1·98	1·99	7·8409	·095	·010	·105	·019	–	–	·161	7,304*	4,644*

TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	–	–	–	–	–	–	–	–	–	–	–	–	11°·6
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·796	–	–	–	–	–	–	–	–	–	–	–	–	7°·8
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	–	–	–	–	–	–	–	–	–	–	–	–	1°·6
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·796	6·8	1·1	5·7	–	–	–	–	–	–	–	–	–	8°·1
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·796	–	–	–	–	–	–	–	–	–	–	–	–	7°·
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·795	–	–	–	–	–	–	–	–	–	–	–	–	7°·4
1·796	6·8	1·1	5·7	–	–	–	–	–	–	–	–	–	7°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 1, at the end.

WHITEHAVEN, CUMBERLAND.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·22
Combined	3·02
Silicon	none.
Sulphur	0·06
Phosphorus	0·11
Manganese	traces.
Arsenic, Copper	

TEST.

TORSION. Breaking Weight. Observed.	TORSION. Breaking Weight. Reduced to per Square Inch.	TORSION. Fracture. Angles from Transverse Base.	TORSION. Fracture. Diameter long.	CRUSHING. Dimensions. Length.	Diameter.	Ratio $\frac{L.}{D.}$	Resistance or Variations in Form under the different Pressures of 15,000 lbs. Depression.	15,000 lbs. Set.	15,000 lbs. Restoration.	20,000 lbs. Depression.	20,000 lbs. Set.	20,000 lbs. Restoration.	25,000 lbs. Depression.	25,000 lbs. Set.	25,000 lbs. Restoration.	30,000 lbs. Depression.	30,000 lbs. Set.	30,000 lbs. Restoration.	35,000 lbs. Depression.	35,000 lbs. Set.	35,000 lbs. Restoration.	Breaking Weight. Observed.	Breaking Weight. Reduced to per Square Inch.	MEAN. Specific Gravity.	MEAN. Tensile.	MEAN. Transverse.	MEAN. Torsion.	MEAN. Crushing.	RATIO—TON AS UNITY. Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·075	12,430	4,355	4,308	48,807	5·549	1·944	1·923	21·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,000	4,308	40°	2·08	1·3	·6	2·16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13,800	48,807								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·090	13,959	4,678	3,883*	49,680	6·231	2·088	1·733*	22·178
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
900*	3,883*	40°	2·00	1·3	·599	2·17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14,000	49,680								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·090	12,922	4,666*	2,369*	44,563	5·768	2·083*	1·057*	19·894
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
550*	2,369*	38°	1·65	1·3	·6	2·16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12,600	44,563								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·101	15,414	4,284	4,354	60,478	6·891	1·912	1·945	26·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,010	4,358	37°	1·71	1·3	·6	2·16	·035	·017	·018	-	-	-	-	-	-	-	-	-	-	-	-	17,100	60,478								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·113	15,376	4,426	3,668	56,588	6·864	1·975	1·637	25·262
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
850	3,668	36°	2·19	1·3	·6	2·16	·029	·014	·015	-	-	-	-	-	-	-	-	-	-	-	-	16,000	56,588								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·112	15,268	5,452	3,760	52,697	6·816	2·433	1·678	23·522
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
870	3,760	39°	2·00	1·3	·6	2·16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14,900	52,697								
897*	3,724*	38°	1·94	1·3	·6	2·16	·032	·016	·016	-	-	-	-	-	-	-	-	-	-	-	-	14,733	52,136	7·097	14,233	4,644*	3,724*	52,136	6·354	2·073*	1·662*	23·275
																								Slow, Gradual, and Quick Cooling — Horizontal	7·085	13,104	4,566*	3,520*	47,683	5·850	2·038*	1·571*	21·287
																								Slow, Gradual, and Quick Cooling — Vertical	7·109	15,363	4,721	3,928	56,588	6·858	2·107	1·753	25·262
																								Combined Means — Horizontally and Vertically Cast — Slow	7·088	13,937	4,319	4,333	54,643	6·221	1·928	1·934	24·394
																								Combined Means — Horizontally and Vertically Cast — Gradual	7·102	14,667	4,552	3,775*	53,134	6·547	2·032	1·685*	23·720
																								Combined Means — Horizontally and Vertically Cast — Quick	7·101	14,095	5,059*	3,064*	48,630	6·292	2·258*	1·367*	21·709
																								Ratio in terms of the Crushing Force						·272	·089	·071	1·000

HÆMATITE IRON COMPANY,

No. 2.—

MANUFACTURE.

Foundry Pig Iron manufactured from pure red Hæmatite Ore.

CASTING.

Cast	6 October 1856.
Barometer	29·99
Thermometer	67·

Weight of—	cwt.	qrs.	lbs.
Charge	4	3	24
Castings	3	0	5
Runners	0	2	23
Slag and waste	0	3	0
Coals consumed	5	3	4

Time of—	hrs.	min.
Melting	1	9
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1522			1	7·239	1·3	·002	·005	·010	–	–	–	–	·013	27,500	20,718
1523	Mark $\frac{11}{2}$.	Slow	2	7·206	1·3	·002	·005	–	–	–	–	–	·013	24,500	18,458
1524			3	7·230	1·299	·003	·006	–	–	–	–	–	·009	23,400	17,656
	CAST.														
1525	6 October 1856.		1	7·209	1·3	·003	·008	–	–	–	–	–	·014	23,000	17,328
1526		Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1527	TESTED.		3	7·228	1·297	·001	·004	–	–	–	–	–	·010	23,200	17,559
	Tensile, 10 Oct. 1857.														
1528	Temp. 60°.		1	7·224	1·3	·001	·005	–	–	–	–	–	·012	23,700	17,855
1529		Quick	2	7·223	1·3	·005	·012	–	–	–	–	–	·017	21,400	16,122
1530	Transverse, 21 Aug. 1857.		3	7·220	1·3	·004	·008	–	–	–	–	–	·014	22,900	17,252
	Temp. 70°.														
1531	Torsion, 14 Oct. 1857.		1	7·196	1·3	·002	·007	–	–	–	–	–	·011	23,900	18,006
1532	Temp. 60°.	Slow	2	–	–	–	–	–	–	–	–	–	–	–	–
1533	Crushing, 25 Jan. 1859.		3	7·197	1·3	·001	·004	–	–	–	–	–	·010	24,900	18,759
	Temp. 55°.														
1534			1	7·221	1·3	·003	·008	–	–	–	–	–	·012	21,000	15,821
1535	FRACTURE.	Gradual	2	7·188	1·299	·001	·005	–	–	–	–	–	·010	23,700*	17,882*
1536	Light Grey.		3	7·210	1·299	·000	·003	–	–	–	–	–	·009	23,000	17,354
	Regular.														
1537	Medium Grain.		1	–	–	–	–	–	–	–	–	–	–	–	–
1538	Good working qualities.	Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1539			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			7·214	1·3	·002	·006	·010	–	–	–	–	·012	23,546*	17,751*

Vertical. Horizontal.

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1522	1·99	2·01	8·0397	·068	·005	–	–	–	–	·128	8,100*	5,037*
1523	1·99	2·02	8·1199	068	·004	–	–	–	–	·125	8,000	4,926
1524	–	–	–	–	–	–	–	–	–	–	–	–
1525	2·02	1·99	7·9994	·065	·005	–	–	–	–	·125	8,100*	5,062*
1526	–	–	–	–	–	–	–	–	–	–	–	–
1527	–	–	–	–	–	–	–	–	–	–	–	–
1528	2·06	2·00	8·2400	·060	·004	–	–	–	–	·111	8,300*	5,036*
1529	1·95	2·05	8·1948	·073	·007	–	–	–	–	·114	7,100*	4,331*
1530	–	–	–	–	–	–	–	–	–	–	–	–
1531	1·96	1·95	7·4529	·066	·004	–	–	–	–	·133	8,500	5,702
1532	–	–	–	–	–	–	–	–	–	–	–	–
1533	–	–	–	–	–	–	–	–	–	–	–	–
1534	1·95	1·98	7·6447	·069	·004	–	–	–	–	·156	9,400	6,147
1535	1·96	1·97	7·6065	·062	·007	–	–	–	–	·089	7,000	4,601
1536	–	–	–	–	–	–	–	–	–	–	–	–
1537	–	–	–	–	–	–	–	–	–	–	–	–
1538	–	–	–	–	–	–	–	–	–	–	–	–
1539	–	–	–	–	–	–	–	–	–	–	–	–
	1·99	1·99	7·8805	·066	·005	–	–	–	–	·120	8,062*	5,105*

Register No.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1522	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1523	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1524	1·797	4·	·5	3·5	–	–	–	–	–	–	–	–	–	4°·8
1525	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1526	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1527	1·794	–	–	–	–	–	–	–	–	–	–	–	–	5°·6
1528	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1529	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1530	1·797	–	–	–	–	–	–	–	–	–	–	–	–	4°·1
1531	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1532	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1533	1·797	3·7	·5	3·2	–	–	–	–	–	–	–	–	–	6°·5
1534	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1535	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1536	1·797	4·2	·8	3·4	–	–	–	–	–	–	–	–	–	8°·2
1537	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1538	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1539	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1·796	3·9	·6	3·3	–	–	–	–	–	–	–	–	–	5°·8

All Specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 2, at the end.

WHITEHAVEN, CUMBERLAND.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·24
Silicon	2·77
Sulphur	0·01
Phosphorus	0·05
Manganese	0·07
Arsenic, Copper	minute traces.

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of												Breaking Weight.											
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·225	18,944	4,981*	4,351*	80,284	8·457	2·223*	1·942*	35·841
1,010*	4,351*	40°	1·61	1·3	·6	2·16	·023	·010	·013	·049	·028	·021	-	-	-	-	-	-	-	-	-	22,700	80,284									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·218	17,443	5,062*	3,940*	81,345	7·787	2·259*	1·758*	36·314
910*	3,940*	41°	1·72	1·3	·6	2·16	·021	·008	·013	·048	·027	·021	-	-	-	-	-	-	-	-	-	23,000	81,345									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·222	17,076	4,683*	2,369*	79,930	7·623	2·090*	1·057*	35·683
550*	2,369*	33°	1·20	1·3	·6	2·16	·029	·015	·014	·058	·034	·024	-	-	-	-	-	-	-	-	-	22,600	79,930									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·196	18,382	5,702	4,954*	87,358	8·206	2·545	2·211*	38·995
1,150*	4,954*	40°	1·95	1·3	·6	2·16	·021	·007	·014	·045	·021	·024	-	-	-	-	-	-	-	-	-	24,700	87,358									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·206	17,019*	5,374	5,299	82,406	7·597*	2·399	2·365	36·788
1,230	5,299	34°	1·94	1·3	·6	2·16	·021	·008	·013	·047	·024	·023	-	-	-	-	-	-	-	-	-	23,300	82,406									
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	—									
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	—	—	—	—	—	—	—	—	—	—
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	—									
970*	4,182*	37°	1·68	1·3	·6	2·16	·023	·010	·013	·049	·027	·022	-	-	-	-	-	-	-	-	-	23,260	82,265	7·214	17,751*	5,105*	4,182*	82,265	7·925*	2·279*	1·866*	36·725
																								Combined Means - - - Slow, Gradual, and Quick Cooling - - - Horizontal - - -		7·222	17,868	4,878*	3,553*	80,520	7·976	2·177*	1·586*	35·946
																									7·201	17,564*	5,483	5,126*	84,884	7·841*	2·448	2·288*	37·894
																								Horizontally and Vertically Cast - - - Slow - - - - -		7·211	18,663	5,341*	4,652*	83,821	8·331	2·384*	2·076*	37·419
																									7·212	17,231*	5,218*	4,619*	81,881	7·692*	2·329*	2·062*	36·554
																									7·222	17,076	4,683*	2,369*	79,930	7·623	2·090*	1·057*	35·683
																								Ratio in terms of the Crushing Force - - -						·215	·062	·050	1·000

HÆMATITE IRON COMPANY,

No. 4.—

MANUFACTURE.

Foundry Pig Iron manufactured from pure red Hæmatite Ore.

CASTING.

Cast	4 October 1856.
Barometer	29·69
Thermometer	67·

Weight of—	cwts.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	0
Runners	0	1	16½
Slag and waste	1	0	20
Coals consumed	3	2	23

Time of—	hrs.	min.
Melting	1	20
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1540	Mark $\frac{11}{3}$.	Slow	1	7·229	1·3	·000	·006	·010	–	–	–	–	·010	25,000	18,834	2·05	1·99	8·1182	·060	·001	·134	·015	–	–	·165	11,500	7,082	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1541			2	7·226	1·3	·001	·004	–	–	–	–	–	·020	22,300	16,800	2·09	1·95	7·8872	·062	·003	·138	·014	–	–	·180	11,800	7,423	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1542	CAST.		3	7·229	1·3	·001	·003	·006	–	–	–	–	·011	26,500	19,965	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·4	·0	2·4	–	–	–	–	–	–	–	–	–	6°·7
1543	4 October 1856.	Horizontal.	1	7·226	1·3	·003	·006	·010	–	–	–	–	·012	25,100	18,909	2·04	2·02	8·3248	·063	·005	·139	·016	–	–	·211	13,400	8,049	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1544			2	7·236	1·3	·003	·007	–	–	–	–	–	·016	24,500	18,458	2·06	2·03	8·4890	·060	·004	·131	·014	–	–	·188	12,900	7,598	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1545	TESTED.		3	7·149	1·3	·002	·005	–	–	–	–	–	·011	24,000	18,081	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·0	·0	3·0	–	–	–	–	–	–	–	–	–	6°·0
1546	Tensile, 10 Oct. 1857. Temp. 60°.	Gradual	1	7·233	1·3	·002	·005	·009	–	–	–	–	·012	27,000	20,341	2·05	2·01	8·2822	·065	·004	·142	·015	–	–	·163	10,500*	6,338*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1547	Transverse, 21 Aug. 1857. Temp. 70°.		2	7·226	1·3	·003	·006	·010	–	–	–	–	·013	27,900	21,019	2·03	2·00	8·1200	·061	·005	·136	·014	–	–	·207	13,200	8,128	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1548			3	7·221	1·3	·000	·002	·005	–	–	–	–	·009	27,400	20,642	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·8	·1	2·7	–	–	–	–	–	–	–	–	–	4°·9
1549	Torsion, 14 Oct. 1857. Temp. 60°.		1	7·035	1·3	·001	·005	·012	–	–	–	–	·012	25,000	18,834	2·01	2·02	8·2016	·067	·004	–	–	–	–	·124	9,500	5,791	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1550	Crushing. 29 Jan. 1859. Temp. 55°.	Slow	2	7·203	1·3	·002	–	–	–	–	–	–	·010	19,500	14,691	1·99	2·00	7·9600	·074	·005	–	–	–	–	·120	7,500*	4,711*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1551			3	7·223	1·3	·000	003	–	–	–	–	–	·009	20,500	15,444	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·6	·0	2·6	–	–	–	–	–	–	–	–	–	4°·5
1552	FRACTURE. Light Grey Bluish. Bright. Regular. Fine Grain. Good working qualities.	Vertical. Gradual	1	7·219	1·3	·003	·010	–	–	–	–	–	·010	20,000	15,067	1·98	1·98	7·7623	·067	·003	–	–	–	–	·106	7,300	4,702	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1553			2	7·225	1·3	·001	·005	–	–	–	–	–	·007	21,000	15,821	1·95	1·96	7·4911	·067	·003	–	–	–	–	·106	7,400	4,939	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1554			3	7·205	1·3	·001	·004	–	–	–	–	–	·008	22,100	16,649	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·2	·1	3·1	–	–	–	–	–	–	–	–	–	4°·5
1555		Quick	1	7·189	1·3	·003	·005	·010	–	–	–	–	·012	26,900	20,266	1·96	1·98	7·6839	·067	·003	–	–	–	–	·116	7,800*	5,075*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1556			2	7·055	1·3	·002	–	–	–	–	–	–	·004	16,000*	12,054*	2·00	2·02	8·1608	·053	·003	–	–	–	–	·142	5,500*	3,369*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1557			3	7·196	1·3	·001	–	–	–	–	–	–	·010	19,000*	14,314*	–	–	–	–	–	–	–	–	–	–	–	–	1·798	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2°·8
	General Mean			7·196	1·3	·001	·005	·009	–	–	–	–	·012	23,317*	17,566*	2·02	2·00	8·0800	·064	·003	·137	·015	–	–	·152	9,858*	6,100*	1·797	2·8	·0	2·8	–	–	–	–	–	–	–	–	–	4°·9

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 3, at the end.

WHITEHAVEN, CUMBERLAND.

PIG IRON.

CHEMICAL ANALYSIS.

Important Constituents in 100 Parts.

Carbon, as Graphite	1·86
Carbon, combined	0·35
Silicon	2·63
Sulphur	0·10
Phosphorus	0·03
Manganese	0·07
Arsenic, Copper	*Minute traces.*

TEST.

TORSION. Breaking Weight. Observed.	TORSION. Breaking Weight. Reduced to per Square Inch.	TORSION. Fracture. Angles from Transverse Base.	TORSION. Fracture. Diameter long.	CRUSHING. Dimensions. Length.	Diameter.	$\frac{L.}{D.}$ Ratio	Resistance or Variations in Form under the different Pressures of 15,000 lbs. Depression.	15,000 lbs. Set.	15,000 lbs. Restoration.	20,000 lbs. Depression.	20,000 lbs. Set.	20,000 lbs. Restoration.	25,000 lbs. Depression.	25,000 lbs. Set.	25,000 lbs. Restoration.	30,000 lbs. Depression.	30,000 lbs. Set.	30,000 lbs. Restoration.	35,000 lbs. Depression.	35,000 lbs. Set.	35,000 lbs. Restoration.	Breaking Weight. Observed.	Breaking Weight. Reduced to per Square Inch.	MEAN. Specific Gravity.	MEAN. Tensile.	MEAN. Transverse.	MEAN. Torsion.	MEAN. Crushing.	RATIO—TON AS UNITY. Tensile.	RATIO—TON AS UNITY. Transverse.	RATIO—TON AS UNITY. Torsion.	RATIO—TON AS UNITY. Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,360	5,849	36°	2·10	1·3	·6	2·16	·020	·006	·014	·042	·019	·023	-	-	-	-	-	-	-	-	-	23,600	83,467	7·228	18,533	7,252	5,849	83,467	8·273	3·237	2·611	37·262
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,300*	5,600*	42°	2·14	1·3	·6	2·16	·020	·010	·010	·046	·028	·018	-	-	-	-	-	-	-	-	-	23,000	81,345	7·203	18,482	7,823	5,600*	81,345	8·250	3·492	2·500*	36·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200	5,161	40°	2·00	1·3	·6	2·16	·018	·004	·014	·039	·016	·023	·088	·054	·034	-	-	-	-	-	-	25,900	91,602	7·226	20,667	7,223*	5,161	91,602	9·226	3·224*	2·304	40·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,150	4,946	41°	2·20	1·3	·6	2·16	·019	·003	·016	·038	·015	·023	·083	·053	·030	-	-	-	-	-	-	25,100	88,772	7·153	16,323	5,251*	4,946	88,772	7·287	2·344*	2·208	39·629
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,130*	4,868*	36°	1·95	1·3	·6	2·16	·019	·004	·015	·044	·019	·025	-	-	-	-	-	-	-	-	-	23,500	83,114	7·216	15,845	4,820	4,868*	83,114	7·073	2·151	2·173*	37·104
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
800*	3,440*	33°	1·50	1·3	·6	2·16	·029	·014	·015	-	-	-	-	-	-	-	-	-	-	-	-	19,000	67,198	7·146	15,544*	4,220*	3,440*	67,198	6·939*	1·884*	1·535*	29·999
1,156*	4,977*	38°	1·99	1·3	·6	2·16	·021	·007	·014	·041	·019	·022	·085	·053	·032	-	-	-	-	-	-	23,350	82,583	7·196	17,566*	6,100*	4,977*	82,583	7·841*	2·723*	2·221*	36·867
Combined Means - - - Slow, Gradual, and Quick Cooling - - - Horizontal - - -																								7·219	19,227	7,436*	5,536*	85,471	8·583	3·319*	2·471*	38·156
Combined Means - - - Slow, Gradual, and Quick Cooling - - - Vertical - - - -																								1·772	15,904*	4,764*	4,418*	79,695	7·100*	2·126*	1·972*	35·677
Combined Means - - - Horizontally and Vertically Cast - - - Slow - - - - -																								7·191	17,428	6,251*	5,397	86,120	7·780	2·790*	2·409	38·446
Combined Means - - - Horizontally and Vertically Cast - - - Gradual - - - -																								7·220	17,163	6,321	5,234*	82,230	7·662	2·821	2·336*	36·709
Combined Means - - - Horizontally and Vertically Cast - - - Quick - - - -																								7·186	18,105*	5,727*	4,300*	79,400	8·082*	2·556*	1·919*	35·446
Ratio in terms of the Crushing Force - - -																													·212	·073	·060	1·000

HÆMATITE FOUNDRY, WHITEHAVEN.

CHEMICAL REPORT on the IRON and MATERIALS employed in its Manufacture.

ORE.

Hæmatite, remarkably free from gangue and impurities generally.

The dried sample contained—

Peroxide of iron	98·71
Oxide of manganese, Lime, Phosphoric acid	traces.
Silica, as quartz	1·00
	99·71
Metallic iron	69·10

FUEL.

1. *Coke, from Newcastle.*
2. *Coke, manufactured at the Works.*

(Employed in the proportion of equal parts.)

Newcastle Coke:

The hard, lustrous variety. An average sample contained—

Of *sulphur*, 0·80 per cent.; and left, on burning, *ash*, 4·45 per cent.

The light red ash consisted of *silicate of alumina*, with *lime* and *peroxide of iron*, and contained traces of *magnesia* and *phosphoric acid*.

Coke, manufactured at the Whitehaven Works:

A more friable kind of coke than the preceding. An average sample contained—

Of *sulphur*, 1·38 per cent; and left, of *ash*, on burning, 12·16 per cent.

The ash consisted of ordinary shale, *silicate of alumina* with *peroxide of iron*, and a little *lime* and *magnesia*; it did not contain any appreciable amount of phosphoric acid.

HÆMATITE FOUNDRY, WHITEHAVEN—*continued.*

FLUXES.

Whitehaven Limestone and Shale Flux.

Whitehaven Limestone:

Fine-grained, crystalline; light brownish-grey in colour, and containing fossil shells (*terebratula*).

(Sample dried at 212 degrees Fahrenheit.)

Carbonate of lime	97·63
Carbonate of magnesia	1·03
Carbonate of iron	0·24
Carbonate of manganese	0·11
Sulphate of lime	0·07
Phosphate of lime	trace.
Carbonaceous matter	0·06
Alumina	0·10
Silica (principally sand)	0·76
	100·00

Shale Flux:

The ordinary black shale of the coal measures (*clay* and *carbonaceous matter*), not containing an appreciable amount of sulphur.

IRONS.

Nos. 1, 2, 3, and 4, Foundry Pig.

The distinction between 2 and 3 is not well marked; analysis shows them to be nearly identical.

Important Constituents in 100 *parts.*

	I.	II.	III.	IV.
Carbon, as graphite	3·22	2·24	2·30	1·86
„ combined	none	small, not determined.		0·35
Silicon	3·02	2·77	2·72	2·63
Sulphur	none	0·01	0·05	0·10
Phosphorus	0·06	0·05	0·05	0·03
Manganese	0·11	0·07	trace	0·07
Arsenic	minute traces.			
Copper				

Remark.—These irons, otherwise remarkably pure, contain an unusually high per-centage of silicon.

MESSRS. ATTWOOD, WEARDALE

No. 1.—

MANUFACTURE.

No. 1.—Pig Iron manufactured from the following ingredients, viz.:—Sparry carbonate of iron or Sparhose iron ore, sometimes called the steel ore of Styria and Corinthia, and of the same as decomposed where the mines lie nearest to the surface, by the action of the atmosphere passing into a state of hydrous and sometimes anhydrous peroxide of iron. Smelted with coke. Limestone used as a flux.

CASTING.

Cast	11 October 1856.
Barometer	30·06
Thermometer	64·

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	1
Runners	0	1	15
Slag and waste	0	2	20
Coals consumed	3	2	5

Time of—	hrs.	min.
Melting	0	48
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1792	Mark $\frac{19}{1}$. CAST. 11 October 1856. TESTED. Tensile, 1 February 1858. Temp. 57°. Transverse, 29 Oct. 1857. Temp. 58°. Torsion, 25 Nov. 1857. Temp. 52°. Crushing, 29 Jan. 1859. Temp. 56°. FRACTURE. Medium Grey. Lustrous. Regular. Medium Grain. Good working qualities.	Horizontal. Slow	1	7·091	1·3	·002	·007	–	–	–	–	–	·010	22,500	16,951
1793			2	7·092	1·3	·001	·004	–	–	–	–	–	·009	22,200	16,725
1794			3	7·089	1·3	·003	·006	–	–	–	–	–	·013	23,900	18,006
1795		Gradual	1	7·096	1·3	·001	·005	–	–	–	–	–	·009	22,100	16,649
1796			2	7·107	1·3	·002	·005	–	–	–	–	–	·010	22,700	17,101
1797			3	7·094	1·3	·002	·004	–	–	–	–	–	·011	24,900	18,759
1798		Quick	1	7·114	1·3	·001	·005	–	–	–	–	–	·009	23,800	17,931
1799			2	7·109	1·3	·001	·004	–	–	–	–	–	·009	23,800	17,931
1800			3	7·097	1·3	·002	·006	–	–	–	–	–	·010	22,500	16,951
1801		Vertical. Slow	1	7·084	1·3	·001	·004	–	–	–	–	–	·007	23,900	18,006
1802			2	7·091	1·3	·001	·005	–	–	–	–	–	·008	23,800	17,931
1803			3	7·109	1·3	·001	·005	–	–	–	–	–	·009	23,600	17,780
1804		Gradual	1	7·093	1·3	·001	·005	–	–	–	–	–	·011	24,900	18,759
1805			2	7·093	1·3	·001	·005	–	–	–	–	–	·011	24,700	18,608
1806			3	7·108	1·3	·002	·005	–	–	–	–	–	·009	24,700	18,608
1807		Quick	1	6·944	1·3	·003	·006	·011	–	–	–	–	·013	27,100	20,416
1808			2	7·091	1·3	·000	·004	·008	–	–	–	–	·009	25,600	19,286
1809			3	7·096	1·3	·001	·004	·009	–	–	–	–	·010	25,300	19,060
	GENERAL MEAN		–	7·088	1·3	·001	·005	·009	–	–	–	–	·010	24,000	18,080

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1792	2·03	1·95	7·7190	·075	·005	–	–	–	–	·164	9,200	5,959
1793	2·05	2·00	8·2000	·071	·005	–	–	–	–	·147	9,000*	5,475*
1794	–	–	–	–	–	–	–	–	–	–	–	–
1795	2·01	1·91	7·3326	·074	·009	–	–	–	–	·159	9,400	6,409
1796	1·98	2·02	8·0791	·080	·006	–	–	–	–	·153	8,500	5,260
1797	–	–	–	–	–	–	–	–	–	–	–	–
1798	2·02	2·02	8·2420	·070	·006	·155	·018	–	–	·155	10,000	6,066
1799	2·01	2·00	8·0400	·067	·005	·146	·017	–	–	·146	10,000	6·218
1800	–	–	–	–	–	–	–	–	–	–	–	–
1801	1·97	1·97	7·6453	·073	·008	–	–	–	–	·155	8,600	5,624
1802	2·00	2·02	8·1608	·068	·006	–	–	–	–	·135	8,800	5,392
1803	–	–	–	–	–	–	–	–	–	–	–	–
1804	2·00	1·97	7·7618	·075	·006	–	–	–	–	·139	8,300	5,346
1805	1·99	2·01	8·0397	·075	·006	–	–	–	–	·138	8,300	5,161
1806	–	–	–	–	–	–	–	–	–	–	–	–
1807	1·99	1·99	7·8805	·064	·009	–	–	–	–	·136	7,100	4,504
1808	1·98	1·97	7·7831	·068	·002	–	–	–	–	·138	8,900	5,791
1809	–	–	–	–	–	–	–	–	–	–	–	–
	2·00	1·98	7·8408	·071	·006	·150	·017	–	–	·147	8,842*	5,600*

Register No.	TORSION. Angle of Torsion under the different Weights applied at 25 inches from Centre of Bar. Diameter.	1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1792	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1793	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1794	1·796	6·1	1·9	4·2	–	–	–	–	–	–	–	–	–	9°·3
1795	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1796	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1797	1·797	5·9	1·9	4·	–	–	–	–	–	–	–	–	–	10°·7
1798	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1799	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1800	1·796	5·2	1·	4·2	–	–	–	–	–	–	–	–	–	11°·4
1801	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1802	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1803	1·796	4·6	·5	4·1	–	–	–	–	–	–	–	–	–	10°·
1804	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1805	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1806	1·790	5·5	1·2	4·3	–	–	–	–	–	–	–	–	–	9°·4
1807	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1808	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1809	1·795	4·5	·8	3·7	–	–	–	–	–	–	–	–	–	10°·2
	1·795	5·3	1·2	4·1	–	–	–	–	–	–	–	–	–	10°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 4, at the end.

IRON COMPANY, NEAR DARLINGTON.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·24
Silicon	1·80
Sulphur	0·04
Phosphorus	0·19
Manganese	1·45
Lead	*minute trace.*

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -	7·090	17,227	5,717*	5,610	66,137	7·960	2·552*	2·504	29·525
1,300	5,610	35°	1·93	1·3	·6	2·16	·030	·015	·015	–	–	–	–	–	–	–	–	–	–	–	–	18,700	66,137									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -	7·099	17,503	5,834	5,600	63,661	7·813	2·604	2·500	28·420
1,300	5,600	37°	2·05	1·3	·6	2·16	·021	·006	·015	–	–	–	–	–	–	–	–	–	–	–	–	18,000	63,661									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -	7·106	17,604	6,142	5,394	64,722	7·858	2·741	2·408	28·892
1,250	5,394	34°	1·84	1·3	·6	2·16	·030	·015	·015	–	–	–	–	–	–	–	–	–	–	–	–	18,300	64,722									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -	7·094	17,905	5,508	5,092	49,514	7·993	3·458	2·273	22·104
1,180	5,092	35°	2·10	1·3	·6	2·16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14,000	49,514									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -	7·098	18,658	5,253	5,056	59,417	8·329	2·345	2·257	26·525
1,160	5,056	39°	1·79	1·3	·6	2·16	·039	·022	·017	–	–	–	–	–	–	–	–	–	–	–	–	16,800	59,417									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -									
- -	- -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	- -	- -	7·043	19,584	5,147	6,311	55,173	8·742	2·297	2·817	24·629
1,460	6,311	35°	1·90	1·3	·6	2·16	·024	·007	·017	–	–	–	–	–	–	–	–	–	–	–	–	15,600	55,173									
1,275	5,510	36°	1·93	1·3	·6	2·16	·029	·013	·016	–	–	–	–	–	–	–	–	–	–	–	–	16,900	59,771	7·088	18,080	5,600*	5,510	59,771	8·071	2·500*	2·459	26·683
Combined Means — Slow, Gradual, and Quick cooling — Horizontal																								7·098	17,445	5,898*	5,534	64,840	7·787	2·633*	2·470	28·946
Combined Means — Slow, Gradual, and Quick cooling — Vertical																								7·078	18,716	5,303	5,486	54,701	8·355	2·367	2·449	24·419
Combined Means — Horizontally and Vertically cast — Slow																								7·092	17,566	5,612*	5,351	57,826	7·841	2·505*	2·388	25·815
Combined Means — Horizontally and Vertically cast — Gradual																								7·099	18,080	5,543	5,328	61,539	8·071	2·474	2·378	27·472
Combined Means — Horizontally and Vertically cast — Quick																								7·075	18,594	5,644	5,852	59,948	8·300	2·519	2·612	26·762
Ratio in terms of the Crushing Force																													·302	·093	·092	1·000

MESSRS. ATTWOOD, WEARDALE IRON

No. 3.—

MANUFACTURE.

No. 1.—Pig Iron manufactured from the following ingredients, viz. :—Sparry carbonate of iron or Spathose iron ore, sometimes called the steel ore of Styria and Corinthia, and of the same as decomposed where the mines lie nearest to the surface, by the action of the atmosphere passing into a state of hydrous and sometimes anhydrous peroxide of iron. Smelted with coke. Limestone used as a flux.

Cast	11 October 1856.
Barometer	30·06
Thermometer	64·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	2	3	19
Runners	1	0	0
Slag and waste	0	2	22
Coals consumed	4	1	9

Time of—	hrs.	min.
Melting	1	2
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.		No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1810				1	7·144	1·3	·002	·006	·010	–	–	–	–	·011	28,500	21,472
1811	Mark $\frac{19}{2}$.		Slow	2	7·137	1·3	·001	·004	·007	·010	–	–	–	·011	31,900	24,033
1812				3	7·162	1·3	·001	·004	·008	–	–	–	–	·010	29,500	22,225
	CAST.															
1813	11 October 1856.			1	7·169	1·3	·001	·004	·006	·010	–	–	–	·010	30,000	22,601
1814		Horizontal.	Gradual	2	7·157	1·3	·002	·004	·006	–	–	–	–	·010	28,000	21,095
1815	TESTED.			3	7·164	1·3	·003	·006	·012	–	–	–	–	·014	29,600	22,300
	Tensile, 3 February 1858.															
1816	Temp. 58°.			1	–	–	–	–	–	–	–	–	–	–	–	–
1817	Transverse, 29 Oct. 1857.		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1818	Temp. 57°.			3	7·156	1·3	·000	·003	·005	·009	–	–	–	·011	31,000	23,355
	Torsion, 25 Nov. 1857.															
1819	Temp. 52°.			1	7·225	1·3	·002	·004	·007	–	–	–	–	·011	29,800	22,451
1820			Slow	2	7·150	1·3	·002	·006	·009	–	–	–	–	·010	27,000	20,341
1821	Crushing, 29 Jan. 1859.			3	7·161	1·3	·002	·004	·006	·009	–	–	–	·011	30,300	22,827
	Temp. 56°.															
1822	FRACTURE.			1	7·147	1·3	·001	·004	·006	·009	–	–	–	·012	30,900	23,279
1823	Light Grey.	Vertical.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1824	Bright.			3	7·153	1·3	·001	·004	·007	–	–	–	–	·009	25,500	19,211
	Regular.															
1825	Medium Grain.			1	7·137	1·3	·002	·006	·010	–	–	–	–	·012	25,200	18,985
1826	Good working qualities.		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1827				3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN				7·158	1·3	·001	·004	·007	·009	–	–	–	·011	29,015	21,859

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1810	2·03	2·01	8·2418	·054	·005	·139	·015	–	–	·205	12,900	7,864	–	–	–	–	–	–	–	–	–	–	–	–	–
1811	1·99	2·05	8·3629	·063	·005	·140	·016	–	–	·185	12,500	7,473	–	–	–	–	–	–	–	–	–	–	–	–	–
1812	–	–	–	–	–	–	–	–	–	–	–	–	1·795	4·	·8	3·2	–	–	–	–	–	–	–	–	4°·6
1813	2·00	2·00	8·0000	·064	·004	·139	·015	–	–	·200	13,300	8,312	–	–	–	–	–	–	–	–	–	–	–	–	–
1814	2·00	2·00	8·0000	·063	·005	·145	·016	–	–	·201	13,700	8,562	–	–	–	–	–	–	–	–	–	–	–	–	–
1815	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·7	·0	2·7	–	–	–	–	–	–	–	–	5°·6
1816	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1817	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1818	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·3	·0	2·3	–	–	–	–	–	–	–	–	11°·0
1819	1·98	2·00	7·9200	·056	·004	·103	·011	–	–	·195	11,750	7,417	–	–	–	–	–	–	–	–	–	–	–	–	–
1820	1·99	2·01	8·0397	·060	·003	·140	·010	–	–	·150	11,000	6,840	–	–	–	–	–	–	–	–	–	–	–	–	–
1821	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·	·0	3·0	–	–	–	–	–	–	–	–	9°·8
1822	1·98	1·96	7·6063	·073	·008	·165	·024	–	–	·170	10,100	6,639	–	–	–	–	–	–	–	–	–	–	–	–	–
1823	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1824	–	–	–	–	–	–	–	–	–	–	–	–	1·796	4·	·6	3·4	–	–	–	–	–	–	–	–	7°·7
1825	1·97	1·97	7·6453	·070	·008	–	–	–	–	·143	9,000	5,885	–	–	–	–	–	–	–	–	–	–	–	–	–
1826	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1827	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1·99	2·00	7·9600	·063	·005	·138	·015	–	–	·181	11,781	7,374	1·796	3·2	·3	2·9	–	–	–	–	–	–	–	–	7°·7

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 5, at the end.

COMPANY, NEAR DARLINGTON.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·26
Silicon	4·25
Sulphur	0·06
Phosphorus	0·07
Manganese	1·04

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,010 *	4,365 *	40°	1·80	1·3	·6	2·16	·022	·009	·013	·045	·022	·023	·095	·063	·032	–	–	–	–	–	–	25,900	91,602	7·147	22,576	7,668	4,365*	91,602	10·078	3·423	1·948*	40·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,300	5,610	39°	1·75	1·3	·6	2·16	·018	·003	·015	·035	·012	·023	·066	·035	·031	–	–	–	–	–	–	28,700	101,505	7·163	21,998	8,437	5,610	101,505	9·820	3·766	2·504	45·312
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,670	7,194	40°	2·09	1·3	·6	2·16	·015	·000	·015	·039	·017	·022	–	–	–	–	–	–	–	–	–	24,900	88,065	7·156	23,355	- -	7,194	88,065	10·426	- -	3·211	39·312
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,560	6,720	36°	1·75	1·3	·6	2·16	·020	·005	·015	·041	·018	·023	·077	·046	·031	–	–	–	–	–	–	26,800	94,785	7·178	21,873	7,128	6,720	94,785	9·764	3·182	3·000	42·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,380	5,955	35°	1·78	1·3	·6	2·16	·023	·009	·014	·055	·031	·024	–	–	–	–	–	–	–	–	–	21,000*	74,272*	7·150	21,245	6,639	5,955	74,272*	9·484	2·963	2·658	33·157*
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·137	18,985	5,885	- -	- -	8·475	2·627	—	—
1,384 *	5,968 *	38°	1·83	1·3	·6	2·16	·020	·005	·015	·043	·020	·023	·079	·048	·031	–	–	–	–	–	–	25,460*	90,046*	7·158	21,859	7,374	5,968*	90,046*	9·758	3·291	2·664*	40·199*

Combined Means					
Slow, Gradual, and Quick cooling	Horizontal	7·155	22,440	8,052	5,723*	93,724	10·017	3·594	2·554*	41·841
	Vertical	7·162	21,182	6,695	6,337	84,529*	9·456	2·988	2·829	37·735*
Horizontally and Vertically cast	Slow	7·162	22,224	7,398	5,542*	92,694	9·921	3·302	2·474*	41·379
	Gradual	7·157	21,621	7,538	5,782	87,889*	9·652	3·365	2·581	39·236*
	Quick	7·147	21,170	5,885	7,194	88,065	9·450	2·627	3·211	39·312
Ratio in terms of the Crushing Force							·242	·081	·066	1·000

MESSRS. ATTWOOD, WEARDALE IRON

No. 4.—

MANUFACTURE.

No. 1.—Pig Iron manufactured from the following ingredients, viz.:—Sparry carbonate of iron or Spathose iron ore, sometimes called the steel ore of Styria and Corinthia, and of the same as decomposed where the mines lie nearest to the surface, by the action of the atmosphere passing into a state of hydrous and sometimes anhydrous peroxide of iron. Smelted with coke. Limestone used as a flux.

CASTING.

Cast	16 October 1856.
Barometer	30·04
Thermometer	64°

Weight of—	cwt.	qrs.	lbs.
Charge	4	0	0
Castings	2	2	19
Runners	0	1	20
Slag and waste	0	1	21
Coals consumed	4	3	22

Time of—	hrs.	min.
Melting	1	10
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1828			1	7·253	1·3	·000	·002	·004	·007	–	–	–	·009	33,500	25,239
1829	Mark $\frac{19}{3}$.	Slow	2	7·281	1·3	·003	·005	·007	·008	–	–	–	·009	31,500	23,732
1830			3	7·275	1·3	·002	·004	·006	·008	–	–	–	·010	33,400	25,163
1831	CAST. 16 October 1856.		1	–	–	–	–	–	–	–	–	–	–	–	–
1832			2	–	–	–	–	–	–	–	–	–	–	–	–
1833	TESTED. Tensile, 3 Febuary 1858. Temp. 58°.	Horizontal. Gradual	3	–	–	–	–	–	–	–	–	–	–	–	–
1834			1	7·282	1·3	·000	·003	·004	·006	–	–	–	·007	31,400	23,656
1835	Transverse, 30 Oct. 1857.	Quick	2	7·268	1·3	·000	·003	·005	·006	–	–	–	·007	32,600	24,560
1836	Temp. 59°.		3	7·291	1·3	·000	·002	·004	·005	–	–	–	·007	34,900	26,293
1837	Torsion, 25 Nov. 1857. Temp. 56°.		1	7·274	1·3	·002	·005	·007	·008	–	–	–	·009	30,900	23,279
1838	Crushing, 29 Jan. 1859.	Slow	2	7·255	1·3	·002	·005	·008	–	–	–	–	·010	29,800	22,451
1839	Temp. 56°.		3	–	–	–	–	–	–	–	–	–	–	–	–
1840	FRACTURE.		1	7·033	1·3	·004	·008	–	–	–	–	–	·011	24,100*	18,156*
1841	Light Grey. Bright. Regular. Fine Grain. Tolerable working qualities.	Vertical. Gradual	2	7·276	1·3	·002	·005	·008	·010	–	–	–	·010	30,000	22,601
1842			3	–	–	–	–	–	–	–	–	–	–	–	–
1843			1	–	–	–	–	–	–	–	–	–	–	–	–
1844		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1845			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			7·248	1·3	·001	·004	·006	·007	–	–	–	·009	31,210*	23,513*

TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
2·01	2·01	8·1206	·037	·003	·118	·008	–	–	·200	14,500	8,927
2·03	2·01	8·2418	·057	·005	·120	·015	–	–	·173	13,500	8,230
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
2·03	1·99	8·0390	·058	·005	·125	·014	–	–	·174	13,800	8,583
2·02	1·93	7·5242	·064	·006	·135	·016	–	–	·220	14,600	9,701
–	–	–	–	–	–	–	–	–	–	–	–
2·00	2·00	8·0000	·060	·010	·106	·016	–	–	·180	11,000	6,875
1·99	2·02	8·1199	·053	·007	·098	·013	–	–	·172	11,000	6,773
–	–	–	–	–	–	–	–	–	–	–	–
1·98	2·02	8·0791	·063	·005	–	–	–	–	·130	9,500*	5,879*
1·99	1·98	7·8015	·065	·005	·137	·014	–	–	·137	10,000	6,408
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
2·01	1·99	7·9598	·057	·006	·120	·014	–	–	·173	12,237*	7,672*

TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1·798	2·9	·4	2·5	–	–	–	–	–	–	–	–	–	4°
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	1·6	·1	1·5	5·8	2·4	3·4	–	–	–	–	–	–	10°·4
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	2·2	·2	2·	5·8	2·4	3·4	–	–	–	–	–	–	7°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 6, at the end.

COMPANY, NEAR DARLINGTON.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·15
Silicon	1·18
Sulphur	0·12
Phosphorus	0·19
Manganese	*trace.*

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,170	5,032	30°	1·50	1·3	·6	2·16	·019	·005	·014	·037	·013	·024	·059	·029	·030	·103	·066	·037	–	–	–	30,700	108,578	7·269	24,711	8,578	5,032	108,578	11·031	3·829	2·246	48·472
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,780	7,668	32°	1·90	1·3	·6	2·16	·020	·007	·013	·039	·015	·024	·059	·028	·031	·099	·061	·038	–	–	–	31,100	109,993	7·280	24,836	9,142	7,668	109,993	11·087	4·081	3·423	49·102
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,475	6,350	31°	1·70	1·3	·6	2·16	·020	·006	·014	·038	·014	·024	·059	·029	·030	·101	·064	·037	–	–	–	30,900	109,286	7·248	23,513*	7,672*	6,350	109,286	10·496*	3·425*	2·834	48·785
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																							7·275	24,773	8,860	6,350	109,286	11·059	3·955	2·834	48·785
Vertical - - - -																							7·209	21,621*	6,843*	- -	- -	9·652*	3·054*	—	—
Horizontally and Vertically cast - - Slow - - - - -																							7·267	23,788	7,701	5,032	108,578	10·619	3·437	2·246	48·472
Gradual - - - -																							7·154	20,378*	6,143*	- -	- -	9·097*	2·742*	—	—
Quick - - - -																							7·280	24,836	9,142	7,668	109,993	11·087	4·081	3·423	49·102
Ratio in terms of the Crushing Force - - -																												·215	·070	·058	1·000

497. ←

MESSRS. ATTWOOD, WEARDALE IRON

REMELTED

MANUFACTURE.

No. 1.—Pig Iron manufactured from the following ingredients, viz.:—Sparry carbonate of iron or Spathose iron ore, sometimes called the steel ore of Styria and Corinthia, and of the same as decomposed where the mines lie nearest to the surface, by the action of the atmosphere passing into a state of hydrous and sometimes anhydrous peroxide of iron. Smelted with coke. Limestone used as a flux.

Cast - - - 16 October 1856.
Barometer - - - 30·04
Thermometer - - 64°

CASTING.

Weight of—	cwts.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	0	4
Runners - -	0	3	26
Slag and waste	0	3	22
Coals consumed	5	0	2

Time of—	hrs.	min.
Melting - - -	1	5
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1846	Mark $\frac{19}{4}$.	Horizontal. Slow	1	7·230	1·3	·000	·000	·001	·003	·005	·006	–	·007	43,800	32,998
1847			2	7·226	1·3	·002	·005	·007	·008	·009	·014	–	·016	42,000	31,642
1848	CAST.		3	7·241	1·3	·002	·005	·006	·007	·008	·011	·012	·013	45,000	33,909
1849	16 October 1856.	Horizontal. Gradual	1	7·217	1·3	·001	·004	·006	·007	·008	·011	–	·013	43,000	32,395
1850	TESTED.		2	7·235	1·3	·002	·005	·007	·008	·010	·013	–	·013	40,000*	30,135*
1851	Tensile, 4 Feb. 1858. Temp. 60°.		3	7·236	1·3	·000	·002	·004	·005	·007	·010	–	·014	43,900	33,078
1852		Horizontal. Quick	1	7·254	1·3	·001	·004	·005	·007	·008	·010	–	·013	42,900*	32,320*
1853	Transverse, 30 Oct. 1857. Temp. 59°.		2	7·258	1·3	·001	·004	·006	·007	·012	·014	–	·017	41,900*	31,567*
1854			3	7·205	1·299	·001	·004	·006	–	–	–	–	·011	29,000*	21,887*
1855	Torsion, 26 Nov. 1857. Temp. 50°.	Vertical. Slow	1	7·091	1·3	·000	·000	·001	·002	·004	·005	–	·006	41,900	31,567
1856	Crushing, 25 Jan. 1859.		2	–	–	–	–	–	–	–	–	–	–	–	–
1857	Temp. 55°.		3	7·035	1·3	·002	·005	·008	·009	·011	·013	–	·015	41,900	31,567
1858	FRACTURE.	Vertical. Gradual	1	–	–	–	–	–	–	–	–	–	–	–	–
1859	Light Grey Bluish. Dull.		2	7·123	1·299	·001	·004	·006	·008	·009	–	–	·010	39,000*	29,427*
1860	Regular. Medium Grain.		3	6·989	1·3	·001	·003	·005	–	–	–	–	·007	29,000*	21,848*
1861	Good working qualities.	Vertical. Quick	1	–	–	–	–	–	–	–	–	–	–	–	–
1862			2	–	–	–	–	–	–	–	–	–	–	–	–
1863			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN - - -			7·180	1·3	·001	·003	·005	·006	·008	·010	·012	·012	40,254*	30,333*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1846	2·03	1·98	7·9584	·053	·003	·114	·010	·191	·031	·250	17,800	11,183	–	–	–	–	–	–	–	–	–	–	–	–	–
1847	2·03	1·99	8·0390	·060	·006	·119	·016	·195	·040	·266	18,000	11,195	–	–	–	–	–	–	–	–	–	–	–	–	–
1848	–	–	–	–	–	–	–	–	–	–	–	–	1·796	1·2	·0	1·2	4·3	·6	3·7	–	–	–	–	–	–	8°·1
1849	2·04	2·02	8·3240	·055	·005	·111	·011	·179	·029	·220	17,300	10,155	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1850	2·04	1·98	7·9976	·056	·005	·114	·012	–	–	·175	14,000	8,752	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1851	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·1	·0	1·1	4·6	1·1	3·5	–	–	–	–	–	–	7°·
1852	1·99	1·99	7·8805	·059	·005	·115	·013	·185	·025	·200	15,800	10,034	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1853	2·01	1·96	7·7216	·055	·003	·117	·010	–	–	·171	14,000*	9,065*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1854	–	–	–	–	–	–	–	–	–	–	–	–	1·796	1·7	·0	1·7	–	–	–	–	–	–	–	–	–	3°·7
1855	2·01	2·01	8·1206	·053	·003	·110	·010	–	–	·164	12,500	7,696	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1856	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1857	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2°	·0	2°	–	–	–	–	–	–	–	–	–	4°·6
1858	2·00	2·04	8·3232	·064	·002	–	–	–	–	·113	8,000*	4,805*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1859	2·03	2·03	8·3654	·052	·001	·112	·010	–	–	·163	12,800*	7,650*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1860	–	–	–	–	–	–	–	–	–	–	–	–	1·798	–	–	–	–	–	–	–	–	–	–	–	–	2°·4
1861	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1862	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1863	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2·02	2·00	8·0800	·056	·004	·114	·011	·187	·031	·191	14,467*	8,948*	1·797	1·5	·0	1·5	4·4	·8	3·6	–	–	–	–	–	–	5°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 7, at the end.

COMPANY, NEAR DARLINGTON.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·21
Silicon	1·88
Sulphur	0·10
Phosphorus	0·19
Manganese	0·13

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–								
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7·232	32,847	11,189	8,328	117,774	14·663	4·995	3·717	52·577
1,930	8,328	36°	2·05	1·3	·6	2·16	·018	·003	·015	·035	·013	·022	·058	·030	·028	·099	·063	·036	–	–	–	33,300	117,774									
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–								
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7·229	31,867*	9,453	7,323*	123,079	14·226*	4·220	3·269*	54·945
1,700*	7,323*	39°	1·90	1·3	·6	2·16	·015	·003	·012	·035	·014	·021	·058	·029	·029	·099	·061	·038	–	–	–	34,800	123,079									
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–								
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7·239	28,591*	6,549*	6,041*	129,799	12·763*	4·262*	2·696*	57·945
1,400*	6,041*	35°	1·50	1·3	·6	2·16	·018	·005	·013	·036	·015	·021	·057	·029	·028	·089	·054	·035	·149	·107	·042	36,700	129,799									
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–								
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7·063	31,567	7,696	5,825*	111,408	14·092	3·435	2·600*	49·735
1,350*	5,825*	35°	1·90	1·3	·6	2·16	·019	·005	·014	·038	·016	·022	·064	·033	·031	·110	·075	·035	–	–	–	31,500	111,408									
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7·056	25,637*	6,227*	3,870*	122,372	11·445*	2·779*	1·727*	54·630
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–								
900*	3,870*	30°	1·33	1·3	·6	2·16	·016	·005	·011	·037	·015	·022	·059	·030	·029	·097	·060	·037	–	–	–	34,600	122,372									
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	—	—	—	—	—	—	—	—	—
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–								
– –	– –	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–								
1,456*	6,277*	35°	1·73	1·3	·6	2·16	·017	·004	·013	·036	·015	·021	·059	·030	·029	·099	·063	·036	·149	·107	·042	34,180	122,216	7·180	30,333*	8,948*	6,277*	122,216	13·541*	3·994*	2·802*	54·558

Combined Means			Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
Slow, Gradual and Quick cooling	Horizontal		34,180	122,216	7·233	31,102*	10,064*	7,230*	123,551	13·884*	4·492*	3·227*	55·156
	Vertical				7·059	28,602*	6,717*	4,847*	116,890	12·768*	2·998*	2·163*	52·183
Horizontally and Vertically cast	Slow				7·148	32,207	9,442	7,076*	114,591	14·378	4·215	3·158*	51·156
	Gradual				7·148	28,752*	7,840*	5,596*	122,726	12·835*	3·500*	2·498*	54·788
	Quick				7·239	28,591*	9,549*	6,041*	129,799	12·763*	4·262*	2·696*	57·945
Ratio in Terms of the Crushing Force										·248	·073	·051	1·000

WEARDALE IRON COMPANY, DURHAM.

(Messrs. Attwood.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ore.

In the Government Report on "the Iron Ores of Great Britain," page 55, will be found the subjoined analysis of a sample of Weardale ore, which, like the specimens received from the works, consisted for the most part of brown hydrated peroxide of iron, still containing, however, a certain quantity of unaltered white carbonate in admixture.

Peroxide of iron	49·50
Protoxide of iron	10·77
Protoxide of manganese	3·06
Alumina	0·43
Lime	5·68
Magnesia	1·20
Silica	0·29
Carbonic acid	14·49
Phosphoric acid	0·01
Bisulphide of iron	0·03
Sulphide of lead	trace.
Water, hygroscopic	1·81
Water, in combination	6·63
Organic matter	trace.
Insoluble residue	6·90
	100·80

Insoluble Residue.

Silica	6·35
Alumina	0·41
Peroxide of iron	0·07
Lime	traces.
Magnesia	
Potash	0·05
	6·88
Metallic iron	43·02

WEARDALE IRON COMPANY, DURHAM—*continued.*

FUEL.

Coke, hard and lustrous, like Newcastle coke. An average sample prepared from the several pieces forwarded, contained—

Sulphur - - - - - - - - 0·60 per cent.

and left, on burning—

Ash - - - - - - - - 5·16 per cent.

The red ash consisted of *silicate of alumina,* with *peroxide of iron,* and a little *lime.*

FLUX.

Limestone, slatey grey in colour, crystalline, contains impressions of fossil shells.

(Sample dried at 212° Fahrenheit.)

Carbonate of lime - - - - -	95·55
Carbonate of magnesia - - - -	3·20
Carbonate of iron - - - - -	trace.
Phosphate of lime - - - - -	0·12
Carbonaceous matter - - - - -	0·23
Sand and clay - - - - - -	0·90
	100·00

IRONS.

Important Constituents in 100 *Parts.*

	I. No. 1 Pig.	II. No. 3 Pig.	III. No. 4 Pig.	IV. Remelted.
Carbon, as graphite - -	3·24	2·26	2·15	2·21
Silicon - - - - -	1·80	4·25	1·18	1·88
Sulphur - - - - -	0·04	0·06	0·12	0·10
Phosphorus - - - -	0·19	0·07	0·19	0·19
Manganese - - - -	1·45	1·04	trace.	0·13

No. 1 Pig was tested for lead, and found to contain a very minute trace of this metal.

Remarks.—The specimens of ore received from the Weardale Iron Company's works were found on examination to be identical in character to the ore, of which the analysis, extracted from the Government Report, is given above.

The composition of No. II. specimen of iron is somewhat anomalous, in regard to the amount of silicon it contains.

The per-centage of phosphorus in the whole of the specimens of iron is low, as would have been predicted from the composition of the ore employed.

MESSRS. SAMUELSON AND COMPANY, SOUTH

No. 2.—

MANUFACTURE.

Toughened pig iron, made with purified coke, smelted under Professor Calvert's patent.

The iron is of the first fusion, as run from the furnace.

CASTING.

Cast	29 September 1856.
Barometer	29·18
Thermometer	65·

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	1
Runners	0	1	4¼
Slag and waste	0	1	14
Coals consumed	6	0	11

Time of—	hrs.	min.
Melting	0	48
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1234		Horizontal. Slow	1	7·135	1·3	·002	·005	–	–	–	–	–	·006	23,000	17,328	1·98	1·99	7·8409	·048	·000	·105	·007	–	–	·120	10,500	6,695	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1235	Mark $\frac{6}{1}$.		2	7·132	1·3	·001	·003	–	–	–	–	–	·004	24,000	18,081	1·98	1·99	7·8409	·050	·000	·121	·009	–	–	·125	10,400	6,631	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1236			3	7·083	1·3	·001	·005	–	–	–	–	–	·007	23,300	17,554	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·5	·3	2·2	–	–	–	–	–	–	–	–	–	5°·5
1237	CAST. 29 September 1856.	Horizontal. Gradual	1	7·126	1·3	·000	·006	–	–	–	–	–	·009	24,600	18,533	2·00	1·95	7·6050	·055	·000	·121	·010	–	–	·125	10,300	6,771	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1238			2	7·132	1·3	·002	·004	–	–	–	–	–	·005	23,900	18,006	1·98	2·03	8·3593	·051	·000	·110	·008	–	–	·115	10,100	6,189	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1239	TESTED. Tensile, 5 June 1857.		3	7·152	1·3	·002	·004	–	–	–	–	–	·010	25,900	19,512	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·	·2	2·8	6·5	2·2	4·3	–	–	–	–	–	–	7°·
1240	Temp. 74°.		1	7·09·	1·3	·003	·005	–	–	–	–	–	·010	26,000	19,588	2·04	2·06	8·6569	·051	·010	·110	·010	–	–	·150	12,700	7,335	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1241	Transverse, 14 Apr. 1857.	Quick	2	7·106	1·3	·003	·006	–	–	–	–	–	·012	23,000	17,328	2·01	2·05	8·4470	·050	·000	·112	·010	–	–	·147	11,900	7,043	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1242	Temp. 55°.		3	7·118	1·3	·005	·008	–	–	–	–	–	·010	23,900	18,006	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·9	·2	2·7	–	–	–	–	–	–	–	–	–	5°·6
1243	Torsion, 4 May 1857. Temp. 56°.		1	7·051	1·299	·003	·005	–	–	–	–	–	·018	23,000	17,354	1·94	1·94	7·3113	·056	·001	–	–	–	–	·094	8,000	5,428	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1244		Slow	2	7·000	1·3	·001	·004	–	–	–	–	–	·006	22,800	17,177	1·94	1·94	7·3113	·050	·000	–	–	–	–	·116	9,700	6,642	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1245	Crushing, 26 Jan. 1859. Temp. 56°.		3	7·109	1·3	·002	·006	·010	–	–	–	–	·011	25,300	19,060	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·6	·1	2·5	–	–	–	–	–	–	–	–	–	6°·
1246	FRACTURE. Light Grey. Bright. Regular. Medium Grain.	Vertical. Gradual	1	7·031	1·3	·000	·001	–	–	–	–	–	·005	23,500	17,705	1·96	2·00	7·9975	·050	·000	–	–	–	–	·109	8,700	5,548	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1247			2	6·993	1·3	·000	·003	–	–	–	–	–	·007	23,900	18,006	2·00	2·02	8·1608	·056	·003	–	–	–	–	·115	9,800	6,004	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1248			3	7·102	1·3	·003	·007	–	–	–	–	–	·008	23,600	17,780	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·2	·0	2·2	–	–	–	–	–	–	–	–	–	3°·2
1249	Tolerable working qualities.	Quick	1	7·044	1·3	·002	·004	–	–	–	–	–	·007	23,700	17,855	1·98	1·98	7·8015	·050	·001	–	–	–	–	·100	9,000	5,768	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1250			2	7·091	1·3	·001	·004	·007	–	–	–	–	·009	28,900	21,773	2·01	2·00	8·0400	·050	·000	–	–	–	–	·112	8,150	5,068	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1251			3	7·110	1·3	·001	·004	·008	–	–	–	–	·010	27,900	21,019	–	–	–	–	–	–	–	–	–	–	–	–	1·795	2·6	·2	2·4	4·8	1·	3·8	–	–	–	–	–	–	7°·4
	General Mean			7·089	1·3	·002	·005	·008	–	–	–	–	·008	24,455	18,425	1·98	2·00	7·9200	·051	·000	·113	·009	–	–	·110	9,937	6,260	1·797	2·6	·2	2·4	5·7	1·6	4·1	–	–	–	–	–	–	5°·7

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 8, at the end.

BANK FURNACES, MIDDLESBRO'-ON-TEES.

TOUGHENED PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·44
Silicon	1·13
Sulphur	0·03
Phosphorus	1·24
Manganese	0·43

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·116	17,654	6,663	6,031	88,065	7·881	2·974	2·692	39·312
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,400	6,031	45°	2·01	1·3	·6	2·16	·018	·004	·014	·035	·013	·022	-	-	-	-	-	-	-	-	24,900	88,065									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·136	18,683	6,430	6,494	86,650	8·340	2·870	2·899	38·683
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,510	6,494	38°	2·01	1·3	·6	2·16	·012	·002	·010	·034	·010	·024	-	-	-	-	-	-	-	-	24,500	86,650									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·107	18,307	7,189	6,226	89,126	8·172	3·209	2·779	39·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,450	6,226	36°	1·58	1·3	·6	2·16	·019	·005	·014	·035	·011	·024	·053	·021	·032	-	-	-	-	-	25,200	89,126									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·053	17,863	6,035	6,386	83,821	7·974	2·694	2·850	37·419
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,480	6,386	40°	1·94	1·3	·6	2·16	·020	·005	·015	·039	·018	·021	-	-	-	-	-	-	-	-	23,700	83,821									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·042	17,830	5,776	5,600	85,236	7·959	2·578	2·500	38·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,300	5,600	42°	2·04	1·3	·6	2·16	·018	·007	·013	·040	·020	·020	-	-	-	-	-	-	-	-	24,100	85,236									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·081	20,215	5,418	7,694	88,419	9·024	2·418	3·434	39·468
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,780	7,694	38°	2·02	1·3	·6	2·16	·017	·003	·014	·032	·011	·021	·070	·040	·030	-	-	-	-	-	25,000	88,419									
1,486	6,405	39°	1·93	1·3	·6	2·16	·017	·004	·013	·036	·014	·022	·062	·031	·031	-	-	-	-	-	24,567	86,886	7·089	18,425	6,260	6,405	86,886	8·225	2·794	2·859	38·785
Combined Means — Slow, Gradual and Quick cooling — Horizontal																							7·120	18,215	6,779	6,250	87,947	8·131	3·026	2·790	39·262
Combined Means — Slow, Gradual and Quick cooling — Vertical																							7·059	18,636	5,743	6,560	85,825	8·319	2·563	2·928	38·314
Combined Means — Horizontally and Vertically cast — Slow																							7·085	17,758	6,349	6,208	85,943	7·927	2·834	2·771	38·367
Combined Means — Horizontally and Vertically cast — Gradual																							7·089	18,256	6,103	6,047	85,943	8·150	2·724	2·699	38·367
Combined Means — Horizontally and Vertically cast — Quick																							7·094	19,261	6,303	6,960	88,773	8·598	2·813	3·107	39·608
																											Ratio in terms of the Crushing Force		·209	·078	·071	1·000

MESSRS. SAMUELSON AND COMPANY, SOUTH

No. 2.—

MANUFACTURE.

No. 1.—Toughened pig iron, made with purified coke, smelted under Professor Calvert's patent.

The iron is of the first fusion, as run from the furnace.

CASTING.

Cast - - 29 September 1856.
Barometer - - 29·18
Thermometer - 65°

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	2	14
Runners - -	0	1	17½
Slag and waste -	0	0	23
Coals consumed -	5	3	11

Time of—	hrs.	min.
Melting - - -	1	16
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1252	Mark $\frac{6}{2}$.	Horizontal. Slow -	1	7·023	1·3	·001	·004	–	–	–	–	–	·007	21,000	15,821
1253			2	7·002	1·3	·001	–	–	–	–	–	–	·003	18,600	14,013
1254	CAST.		3	7·009	1·3	·001	–	–	–	–	–	–	·003	18,500	13,938
1255	29 September 1856.		1	7·036	1·3	·001	–	–	–	–	–	–	·004	18,500	13,938
1256	TESTED.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1257	Tensile, 5 June 1857. Temp. 74°.		3	7·006	1·3	·002	–	–	–	–	–	–	·004	18,900	14,239
1258	Transverse, 17 Apr. 1857.		1	7·000	1·3	·002	·007	–	–	–	–	–	·008	20,100	15,142
1259	Temp. 57°.	Quick -	2	7·039	1·3	·000	·004	–	–	–	–	–	·007	21,800	16,424
1260	Torsion, 6 May 1857.		3	7·023	1·3	·001	·005	–	–	–	–	–	·006	21,900	16,499
1261	Temp. 57°.		1	7·024	1·3	·002	·006	–	–	–	–	–	·008	20,400	15,368
1262	Crushing, 26 Jan. 1859.	Slow -	2	7·040	1·3	·001	·004	–	–	–	–	–	·006	21,300	16,047
1263	Temp. 56°.		3	7·027	1·3	·001	·003	–	–	–	–	–	·005	21,800	16,424
1264	FRACTURE.	Vertical.	1	7·039	1·3	·002	·005	–	–	–	–	–	·006	21,700	16,348
1265	Light Grey. Bright.	Gradual	2	7·005	1·3	·004	·007	–	–	–	–	–	·009	23,200	17,478
1266	Regular. Fine Grain.		3	7·042	1·3	·004	·008	–	–	–	–	–	·010	24,400	18,382
1267	Good working qualities.		1	7·043	1·3	·001	·004	–	–	–	–	–	·006	21,600	16,273
1268		Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–
1269			3	7·013	1·3	·001	·004	–	–	–	–	–	·005	22,600	17,026
	GENERAL MEAN - - -			7·023	1·3	·002	·005	–	–	–	–	–	·006	21,019	15,835

TRANSVERSE. Dimensions. Breadth.	Depth.	BD^2.	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
2·02	1·97	7·8394	·055	·001	–	–	–	–	·127	10,000	6,378
1·97	2·03	8·1181	·052	·001	–	–	–	–	·105	9,000	5,543
–	–	–	–	–	–	–	–	–	–	–	–
1·93	2·05	8·3629	·055	·001	–	–	–	–	·126	9,300	5,560
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
2·01	1·93	7·4870	·059	·002	–	–	–	–	·111	8,200	5,476
1·96	2·02	7·9975	·059	·002	–	–	–	–	·116	8,800	5,501
–	–	–	–	–	–	–	–	–	–	–	–
1·98	1·99	7·8409	·059	·004	–	–	–	–	·116	7,900	5,037
1·98	1·99	7·8409	·059	·005	–	–	–	–	·109	8,100	5,165
–	–	–	–	–	–	–	–	–	–	–	–
1·98	1·99	7·8409	·055	·003	–	–	–	–	·109	8,400	5,356
1·98	2·04	8·2399	·055	·005	–	–	–	–	·115	8,900	5,400
–	–	–	–	–	–	–	–	–	–	–	–
1·97	2·01	7·9589	·056	·002	–	–	–	–	·126	9,900	6,219
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
1·98	2·00	7·9200	·056	·003	–	–	–	–	·105	8,850	5,563

TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·8	3·5	·3	3·2	–	–	–	–	–	–	–	–	–	6°·2
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·798	3·5	·8	2·7	–	–	–	–	–	–	–	–	–	7°·
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·8	3·8	·8	3·	–	–	–	–	–	–	–	–	–	5°·
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·8	3·4	·6	2·8	–	–	–	–	–	–	–	–	–	7°·2
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·798	3·6	·7	2·9	–	–	–	–	–	–	–	–	–	7°·5
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	3·5	·8	2·7	–	–	–	–	–	–	–	–	–	6°·1
1·799	3·5	·6	2·9	–	–	–	–	–	–	–	–	–	6°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 9, at the end.

BANK FURNACES, MIDDLESBRO'-ON-TEES.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·04
Silicon	2·73
Sulphur	0·04
Phosphorus	1·30
Manganese	0·38

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,300	5,572	40°	2·11	1·3	·6	2·16	·020	·006	·014	·050	·030	·020	-	-	-	-	-	-	-	-	-	21,600	76,394	7·011	14,590	5,960	5,572	76,394	6·513	2·660	2·487	34·104
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200	5,161	41°	2·30	1·3	·6	2·16	·021	·011	·010	·080	·060	·020	-	-	-	-	-	-	-	-	-	20,500	72,503	7·021	14,088	5,560	5,161	72,503	6·289	2·482	2·304	32·367
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,350	5,787	40°	2·00	1·3	·6	2·16	·017	·002	·015	·030	·010	·020	-	-	-	-	-	-	-	-	-	24,900	88,065	7·020	16,021	5,488	5,787	88,065	7·152	2·450	2·583	39·312
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,320	5,658	40°	1·91	1·3	·6	2·16	·021	·008	·013	·070	·051	·019	-	-	-	-	-	-	-	-	-	20,200	71,442	7·030	15,946	5,101	5,658	71,442	7·118	2·277	2·525	31·892
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,370	5,892	35°	2·23	1·3	·6	2·16	·019	·009	·010	·050	·029	·021	-	-	-	-	-	-	-	-	-	22,000	77,808	7·028	17,402	5,378	5,892	77,808	7·768	2·400	2·630	34·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,320	5,686	40°	2·20	1·3	·6	2·16	·016	·002	·014	·035	·014	·021	-	-	-	-	-	-	-	-	-	23,000	81,345	7·028	16,649	6,219	5,686	81,345	7·432	2·776	2·538	36·314
1,301	5,626	39°	2·12	1·3	·6	2·16	·019	·006	·013	·053	·032	·021	-	-	-	-	-	-	-	-	-	22,033	77,926	7·023	15,835	5,563	5,626	77,926	7·069	2·483	2·511	34·788
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·017	15,001	5,691	5,506	78,987	6·696	2·540	2·458	35·262
Vertical - - - -																								7·029	16,668	5,435	5,745	76,865	7·441	2·426	2·564	34·314
Horizontally and Vertically cast - - - Slow - - - - -																								7·021	15,268	5,530	5,615	73,918	6·816	2·468	2·506	32·999
Gradual - - - -																								7·025	15,475	5,469	5,526	75,155	7·029	2·441	2·466	33·151
Quick - - - -																								7·024	16,335	5,853	5,736	84,705	7·292	2·612	2·560	37·814
Ratio in terms of the Crushing Force - - -																													·203	·071	·073	1·000

497. ←

SOUTH BANK FURNACES, MIDDLESBRO'-ON-TEES.

(Messrs. Samuelson & Co.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ore.

A dull green, earthy, carbonate of iron, with silicate, containing abundance of small oolitic concretions, a few belemnite stems, and other fossil remains. Small crystals of quartz, of zinc blende, and apparently also of titanite, were found in the specimen examined.

An average sample contained in 100 parts—

Protoxide of iron	43·02
Peroxide of iron	2·86
Protoxide of manganese	0·40
Alumina	5·87
Lime	5·14
Magnesia	5·21
Carbonic acid	25·50
Phosphoric acid	1·81
Silica, soluble modification	7·12
Silica, as quartz	0·05
Titanic acid	traces.
Sulphide of zinc	
Organic matter	0·15
Water, hygroscopic	0·34
Water, in combination	3·14
	100·61
Metallic iron	35·46

The ore does not contain any appreciable amount of sulphur, nor of heavy metals.

Fuel.

Coke, a hard, lustrous variety. In the sample was found imbedded a small nodule of sulphide of iron, derived from pyrites in the coal. An average sample of the coke contained—

Sulphur - - - - - - - 1·05 per cent.

and left, on burning—

Ash - - - - - - - - 5·03 per cent.

The ash, light red, consisted of *silicate of alumina, peroxide of iron*, with small quantities of *lime* and *magnesia*, and did not contain any appreciable amount of phosphoric acid.

BYERS, IRON WORKS, STOCKTON-ON-TEES.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·35
Silicon	1·57
Sulphur	0·04
Phosphorus	1·38
Manganese	0·07

TEST.

TORSION. Breaking Weight. Observed.	TORSION. Breaking Weight. Reduced to per Square Inch.	TORSION. Fracture. Angles from Transverse Base.	TORSION. Fracture. Diameter long.	CRUSHING. Dimensions. Length.	Diameter.	Ratio $\frac{L}{D}$.	Resistance or Variations in Form under the different Pressures of 15,000 lbs. Depression.	15,000 lbs. Set.	15,000 lbs. Restoration.	20,000 lbs. Depression.	20,000 lbs. Set.	20,000 lbs. Restoration.	25,000 lbs. Depression.	25,000 lbs. Set.	25,000 lbs. Restoration.	30,000 lbs. Depression.	30,000 lbs. Set.	30,000 lbs. Restoration.	35,000 lbs. Depression.	35,000 lbs. Set.	35,000 lbs. Restoration.	CRUSHING. Breaking Weight. Observed.	CRUSHING. Breaking Weight. Reduced to per Square Inch.	MEAN. Specific Gravity.	MEAN. Tensile.	MEAN. Transverse.	MEAN. Torsion.	MEAN. Crushing.	RATIO—TON AS UNITY. Tensile.	RATIO—TON AS UNITY. Transverse.	RATIO—TON AS UNITY. Torsion.	RATIO—TON AS UNITY. Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,310	5,615	39°	2·27	1·3	·6	2·16	·019	·003	·016	·035	·012	·023	·060	·031	·029	–	–	–	–	–	–	28,400	100,444	7·167	26,293	7,828	5,615	100,444	11·737	3·494	2·506	44·841
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,050*	4,523*	37°	1·92	1·3	·6	2·16	·017	·003	·014	·036	·014	·022	·060	·032	·028	–	–	–	–	–	–	28,000	99,029	7·147	25,037	7,384	4,523*	99,029	11·177	3·296	2·019*	44·205
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,450	6,246	37°	1·95	1·3	·6	2·16	·018	·003	·015	·035	·012	·023	·056	·029	·027	–	–	–	–	–	–	28,900	102,212	7·171	27,498	7,760	6,246	102,212	12·275	3·464	2·788	45·629
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,580	6,818	40°	2·05	1·3	·6	2·16	·019	·003	·016	·037	·015	·022	·066	·036	·030	–	–	–	–	–	–	27,400	96,907	7·145	25,740	6,551	6,818	96,907	11·491	2·924	3·043	43·262
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,430	6,160	39°	2·44	1·3	·6	2·16	·019	·004	·015	·036	·013	·023	·061	·030	·031	–	–	–	–	–	–	28,000	99,029	7·110	24,484	6,272	6,160	99,029	10·930	2·800	2·750	44·205
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
1,364*	5,872*	38°	2·12	1·3	·6	2·16	·018	·003	·015	·036	·013	·023	·061	·031	·030	–	–	–	–	–	–	28,140	99,524	7·148	25,810	7,159	5,872*	99,524	11·522	3·195	2·621*	44·428
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·162	26,276	7,657	5,461*	100,562	11·730	3·418	2·437*	44·893
Vertical - - - -																								7·127	25,112	6,412	6,489	97,968	11·210	2·862	2·896	43·735
Horizontally and Vertically cast - - - Slow - - - - -																								7·156	26,016	7,189	6,216	98,676	11·614	3·209	2·775	44·051
Gradual - - - -																								7·129	24,760	6,828	5,341*	99,029	11·053	3·048	2·384*	44·205
Quick - - - -																								7·171	27,498	7,760	6,246	102,212	12·275	3·464	2·788	45·629
Ratio in terms of the Crushing Force - - -																													·259	·071	·059	1·000

MESSRS. HOLDSWORTH, BENNINGTON AND

No. 1.—

MANUFACTURE.

Pig Iron manufactured by hot blast from Cleveland ironstone, with a little hæmatite, and of the first melting.

The iron is made with coke from Byer's Green Colliery, near Durham, iron ore from the Belmont Mines, and limestone from the Broadwood Quarries in Weardale.

CASTING.

Cast	9 October 1856.
Barometer	30·17
Thermometer	64·

Weight of—	cwt.	grs.	lbs.
Charge	4	1	10
Castings	3	1	15
Runners	0	1	26
Slag and waste	1	1	3
Coals consumed	3	1	0

Time of—	hrs.	min.
Melting	0	43
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1702		Horizontal. Slow	1	7·156	1·3	·002	·004	·007	·008	·012	–	–	·012	35,000	26,368	2·02	1·98	7·9192	·056	·006	·115	·013	–	–	·160	12,500	7,892	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1703	Mark $\frac{15}{1}$.		2	7·168	1·3	·001	·003	·005	·007	–	–	–	·012	34,900	26,293	2·02	2·02	8·2420	·050	·005	·110	·010	–	–	·150	12,800	7,764	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1704			3	7·177	1·3	·004	·005	·007	·010	–	–	–	·011	34,800	26,218	–	–	–	–	–	–	–	–	–	–	–	–	1·8	2·2	·1	2·1	–	–	–	–	–	–	–	–	–	4°·
1705	CAST. 9 October 1856.		1	7·135	1·3	·003	·005	·007	·008	–	–	–	·008	30,000	22,601	2·04	2·00	8·1600	·050	·003	·106	·010	–	–	·160	13,800	8,455	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1706		Gradual	2	7·139	1·3	·003	·008	·010	·012	–	–	–	·015	34,800	26,218	2·04	1·98	7·9976	·054	·004	·111	·009	–	–	·125	10,100	6,314	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1707	TESTED. Tensile, 12 January 1857.		3	7·169	1·3	·003	·005	·008	·009	–	–	–	·011	34,900	26,293	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·8	·0	1·8	–	–	–	–	–	–	–	–	–	3°·
1708	Temp. 60°.		1	7·158	1·3	·002	·005	·007	·009	·011	–	–	·013	37,300	28,101	2·01	2·03	8·2830	·050	·004	·106	·010	–	–	·145	12,500	7,545	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1709	Transverse, 27 Oct. 1857.	Quick	2	7·173	1·3	·003	·005	·008	·010	·012	–	–	·014	37,200	28,025	2·04	1·96	7·8368	·060	·007	·123	·014	–	–	·162	12,500	7·975	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1710	Temp. 59°.		3	7·182	1·3	·002	·003	·005	·007	·010	–	–	·010	35,000	26,368	–	–	–	–	–	–	–	–	–	–	–	–	1·797	·8	·0	·8	–	–	–	–	–	–	–	–	–	4°·
1711	Torsion, 24 Oct. 1857. Temp. 57°.		1	7·146	1·3	·002	·005	·007	·008	–	–	–	·009	34,000	25,615	1·94	1·96	7·4527	·056	·004	·117	·010	–	–	·121	10,500	7,044	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1712		Slow	2	7·130	1·3	·002	·005	·007	·009	–	–	–	·011	34,200	25,765	1·96	2·00	7·8400	·056	·003	–	–	–	–	·117	9,500	6,058	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1713	Crushing, 26 Jan. 1859. Temp. 56°.		3	7·159	1·3	·002	·004	·006	·007	–	–	–	·008	34,300	25,841	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·	·0	2·	3·8	1·8	2·	–	–	–	–	–	–	5°·7
1714	FRACTURE. Light Grey. Dull. Regular. Fine Grain. Tolerable working qualities.	Vertical. Gradual	1	7·124	1·3	·002	·005	·008	·009	–	–	–	·010	32,300	24,334	1·94	1·95	7·3768	·053	·001	–	–	–	–	·114	9,800	6,642	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1715			2	7·087	1·3	·002	·005	·008	·009	–	–	–	·011	32,300	24,334	1·94	1·96	7·4527	·053	·003	–	–	–	–	·111	8,800	5,903	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1716			3	7·120	1·3	·002	·005	·007	·008	–	–	–	·010	32,900	24,786	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·7	·0	1·7	–	–	–	–	–	–	–	–	–	4°·2
1717		Quick	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1718			2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1719			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			7·148	1·3	·002	·005	·007	·009	·011	–	–	·011	34,200	25,810	2·00	1·98	7·9202	·053	·004	·112	·011	–	–	·136	11,280	7,159	1·797	1·7	·0	1·7	3·8	1·8	2·	–	–	–	–	–	–	4°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 10, at the end.

BYERS, IRON WORKS, STOCKTON-ON-TEES.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·35
Silicon	1·57
Sulphur	0·04
Phosphorus	1·38
Manganese	0·07

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·167	26,293	7,828	5,615	100,444	11·737	3·494	2·506	44·841
1,310	5,615	39°	2·27	1·3	·6	2·16	·019	·003	·016	·035	·012	·023	·060	·031	·029	-	-	-	-	-	-	28,400	100,444									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·147	25,037	7,384	4,523*	99,029	11·177	3·296	2·019*	44·205
1,050*	4,523*	37°	1·92	1·3	·6	2·16	·017	·003	·014	·036	·014	·022	·060	·032	·028	-	-	-	-	-	-	28,000	99,029									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·171	27,498	7,760	6,246	102,212	12·275	3·464	2·788	45·629
1,450	6,246	37°	1·95	1·3	·6	2·16	·018	·003	·015	·035	·012	·023	·056	·029	·027	-	-	-	-	-	-	28,900	102,212									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·145	25,740	6,551	6,818	96,907	11·491	2·924	3·043	43·262
1,580	6,818	40°	2·05	1·3	·6	2·16	·019	·003	·016	·037	·015	·022	·066	·036	·030	-	-	-	-	-	-	27,400	96,907									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·110	24,484	6,272	6,160	99,029	10·930	2·800	2·750	44·205
1,430	6,160	39°	2·44	1·3	·6	2·16	·019	·004	·015	·036	·013	·023	·061	·030	·031	-	-	-	-	-	-	28,000	99,029									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,364*	5,872*	38°	2·12	1·3	·6	2·16	·018	·003	·015	·036	·013	·023	·061	·031	·030	-	-	-	-	-	-	28,140	99,524	7·148	25,810	7,159	5,872*	99,524	11·522	3·195	2·621*	44·428
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																						7·162	26,276	7,657	5,461*	100,562	11·730	3·418	2·437*	44·893
Combined Means - - - Slow, Gradual and Quick cooling - - - Vertical - - - -																						7·127	25,112	6,412	6,489	97,968	11·210	2·862	2·896	43·735
Combined Means - - - Horizontally and Vertically cast - - - Slow - - - - -																						7·156	26,016	7,189	6,216	98,676	11·614	3·209	2·775	44·051
Combined Means - - - Horizontally and Vertically cast - - - Gradual - - - -																						7·129	24,760	6,828	5,341*	99,029	11·053	3·048	2·384*	44·205
Combined Means - - - Horizontally and Vertically cast - - - Quick - - - -																						7·171	27,498	7,760	6,246	102,212	12·275	3·464	2·788	45·629
Ratio in terms of the Crushing Force - - -																											·259	·071	·059	1·000

MESSRS. HOLDSWORTH, BENNINGTON AND

No. 3.—

MANUFACTURE.

Pig Iron manufactured by hot blast from Cleveland ironstone, with a little hæmatite, and of the first melting.

The iron is made with coke from Byer's Green Colliery, near Durham, iron ore from the Belmont Mines, and limestone from the Broadwood Quarries in Weardale.

CASTING.

Cast - - - 17 October 1856.
Barometer - - - - 30·36
Thermometer - - - - 65·

Weight of—	cwt.	qrs.	lbs.
Charge - -	4	0	21
Castings - -	3	1	11
Runners - -	0	1	13
Slag and waste	0	2	15
Coals consumed	3	3	2

Time of—	hrs.	min.
Melting - - -	0	50
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1720			1	7·122	1·3	·002	·005	·008	·010	–	–	–	·010	30,000	22,601
1721	Mark $\frac{15}{2}$.	Slow -	2	7·122	1·3	·001	·004	·005	·007	–	–	–	·010	32,000	24,108
1722			3	7·147	1·3	·003	·006	·009	·010	–	–	–	·011	31,300	23,582
	CAST.														
1723	17 October 1856.		1	7·143	1·3	·002	·005	·007	–	–	–	–	·010	29,000	21,848
1724		Horizontal. Gradual	2	7·151	1·3	·003	·006	·009	–	–	–	–	·011	29,000	21,848
1725	TESTED.		3	7·139	1·3	·001	·003	·005	·006	–	–	–	·008	30,400	22,902
	Tensile, 27 Jan. 1858.														
1726	Temp. 60°.		1	7·123	1·3	·002	·004	·006	–	–	–	–	·009	29,500	22,224
1727	Transverse, 27 Oct. 1857.	Quick -	2	7·139	1·3	·003	·006	·010	–	–	–	–	·012	29,000	21,848
1728	Temp. 58°.		3	7·149	1·3	·000	·003	·004	·006	–	–	–	·007	30,400	22,902
	Torsion, 24 Oct. 1857.														
1729	Temp. 57°.		1	7·125	1·3	·002	·005	·008	–	–	–	–	·010	28,200	21,245
1730		Slow -	2	–	–	–	–	–	–	–	–	–	–	–	–
	Crushing, 26 Jan. 1859.														
1731	Temp. 56°.		3	7·137	1·3	·003	·006	·009	–	–	–	–	·012	27,300	20,567
1732	FRACTURE.		1	7·126	1·3	·001	·003	·005	–	–	–	–	·007	28,400	21,396
1733	Light Grey.	Vertical. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1734	Dull Bluish.		3	7·132	1·3	·000	·002	·004	–	–	–	–	·006	28,000	21,095
	Regular.														
1735	Fine Grain.		1	7·133	1·297	·001	·003	·005	–	–	–	–	·008	29,900	22,630
1736	Tolerable working qualities.	Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–
1737			3	7·139	1·3	·001	·004	·006	·008	–	–	–	·009	30,900	23,279
	GENERAL MEAN - - -			7·135	1·3	·002	·004	·006	·008	–	–	–	·009	29,553	22,271

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1720	1·99	1·97	7·7229	·055	·004	·119	·010	–	–	·144	11,500	7,445	–	–	–	–	–	–	–	–	–	–	–	–	–
1721	1·98	2·01	7·9993	·055	·003	·117	·010	–	–	·138	11,500	7,188	–	–	–	–	–	–	–	–	–	–	–	–	–
1722	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·4	0·1	2·3	–	–	–	–	–	–	–	–	5°·1
1723	2·02	1·99	7·9994	·058	·004	·124	·013	–	–	·143	11,200	7,000	–	–	–	–	–	–	–	–	–	–	–	–	–
1724	2·04	1·99	8·0786	·055	·003	·119	·009	–	–	·145	11,800	7,303	–	–	–	–	–	–	–	–	–	–	–	–	–
1725	–	–	–	–	–	–	–	–	–	–	–	–	1·8	2·5	·0	2·5	–	–	–	–	–	–	–	–	4°·5
1726	2·02	2·00	8·0800	·056	·005	·120	·012	–	–	·140	11,500	7,116	–	–	–	–	–	–	–	–	–	–	–	–	–
1727	2·01	2·01	8·1206	·055	·003	·116	·010	–	–	·149	12,300	7,573	–	–	–	–	–	–	–	–	–	–	–	–	–
1728	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·	·0	2·	–	–	–	–	–	–	–	–	5°·6
1729	1·99	1·98	7·8015	·055	·003	–	–	–	–	·120	10,000	6,408	–	–	–	–	–	–	–	–	–	–	–	–	–
1730	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1731	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·5	·0	1·5	–	–	–	–	–	–	–	–	5°·5
1732	1·96	1·96	7·5295	·056	·004	–	–	–	–	·114	9,000	5,976	–	–	–	–	–	–	–	–	–	–	–	–	–
1733	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1734	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·5	·0	2·5	–	–	–	–	–	–	–	–	6°·1
1735	1·96	1·97	7·6063	·054	·003	–	–	–	–	·116	9,700	6,376	–	–	–	–	–	–	–	–	–	–	–	–	–
1736	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1737	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·5	·0	1·5	–	–	–	–	–	–	–	–	7°·3
	1·99	1·99	7·8805	·055	·003	·119	·010	–	–	·134	10,944	6,932	1·798	2·	·0	2·	–	–	–	–	–	–	–	–	5°·7

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 11, at the end.

BYERS, IRON WORKS, STOCKTON-ON-TEES.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·31
Silicon	1·43
Sulphur	0·03
Phosphorus	1·36
Manganese	0·06

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·130	23,430	7,316	6,150	95,139	10·459	3·266	2·745	42·472
1,430	6,150	38°	2·11	1·3	·6	2·16	·018	·002	·016	·034	·012	·022	·065	·033	·032	-	-	-	-	-	-	26,900	95,139									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·144	22,166	7,151	5,058	88,065	9·895	3·192	2·258	39·312
1,180	5,058	40°	1·80	1·3	·6	2·16	·019	·003	·016	·037	·015	·022	-	-	-	-	-	-	-	-	-	24,900	88,065									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·137	22,324	7,344	6,408	86,650	9·966	3·278	2·860	38·683
1,490	6,408	40°	2·11	1·3	·6	2·16	·019	·005	·014	·037	·015	·022	-	-	-	-	-	-	-	-	-	24,500	86,650									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·131	20,906	6,408	6,505	79,577	9·333	2·860	2·904	35·525
1,510	6,505	37°	2·24	1·3	·6	2·16	·020	·005	·015	·045	·021	·024	-	-	-	-	-	-	-	-	-	22,500	79,577									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·129	21,245	5,976	6,483	84,882	9·484	2·667	2·894	37·893
1,510	6,483	42°	1·83	1·3	·6	2·16	·020	·005	·015	·042	·019	·023	-	-	-	-	-	-	-	-	-	24,000	84,882									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·136	22,954	6,376	7,225	88,065	10·247	2·846	3·225	39·312
1,680	7,225	37°	2·20	1·3	·6	2·16	·018	·005	·013	·040	·017	·023	-	-	-	-	-	-	-	-	-	24,900	88,065									
1,466	6,305	39°	2·05	1·3	·6	2·16	·019	·004	·015	·039	·017	·022	·065	·033	·032	-	-	-	-	-	-	24,617	87,063	7·135	22,271	6,932	6,305	87,063	9·942	3·094	2·814	38·867
Combined Means - - - Slow, Gradual, and Quick cooling - -																						Horizontal - - -		7·137	22,657	7,271	5,872	89,951	10·114	3·245	2·621	40·156
																						Vertical - - - -		7·132	21,702	6,253	6,737	84,175	9·688	2·791	3·007	37·578
																						Slow - - - - -		7·131	22,168	6,862	6,327	87,358	9·896	3·063	2·824	38·995
																						Gradual - - - -		7·137	21,705	6,563	5,770	86,474	9·689	2·929	2·575	38·604
																						Quick - - - - -		7·137	22,639	6,860	6,816	87,358	10·106	3·062	3·042	38·995
																						Ratio in terms of the Crushing Force - - -							·255	·079	·072	1·000

STOCKTON IRONWORKS.

MESSRS. HOLDSWORTH, BENNINGTON, AND BYERS.

CHEMICAL REPORT on the IRON, and MATERIALS employed in its Manufacture.

ORE.

Cleveland Iron Ore from the Belmont Mines.—Together with the samples of iron ore forwarded by the firm, an analysis was furnished, which, with the substitution of 1·60 for 1·30 per cent. for the amount of phosphoric acid, expresses very fairly the composition of their ores. They are very similar in character to the sample of Middlesbro' ore, previously analysed (Series 3); but from the appearance of greater density and compactness, would seem to have been derived from a lower measure.

The composition of the ore is represented by the following Table:—

Protoxide of iron	39·00
Peroxide of iron	3·50
Protoxide of manganese	1·30
Alumina	7·46
Lime	7·44
Magnesia	3·82
Carbonic acid	23·06
Phosphoric acid	1·60
Silica	9·46
Water	3·66
	100·30
Metallic iron	32·78

FUEL.

Coke.—An average sample contained—

Sulphur - - - - - - - 0·91 per cent.

and left, on burning—

Ash - - - - - - - 7·90 per cent.

The ash consisted of burnt shale with a little sand, and contained, therefore, *silica*, *alumina*, *peroxide of iron*, and a little *lime*.

STOCKTON IRONWORKS—*continued.*

FLUX.

Limestone from the Broadwood Quarries.—Dark grey in colour, crystalline.

(Dried at 212° Fahrenheit.)

Carbonate of lime	95·92
Carbonate of magnesia	1·85
Carbonate of iron	0·53
Carbonate of manganese	traces.
Organic matter	
Silicious matter	1·70
	100·00

IRONS.

Important Constituents in 100 *Parts.*

	No. 1 Pig.	No. 3 Pig.
Carbon, as graphite	3·35	3·31
Silicon	1·57	1·43
Sulphur	0·04	0·03
Phosphorus	1·38	1·36
Manganese	0·07	0.06

Remark.—The large amount of phosphorus in these specimens of iron, has evidently been derived from the phosphoric acid contained in the ore employed.

MESSRS. NEEDHAM AND COMPANY, BUTTERLEY

No. 1.—

MANUFACTURE.

Pig iron, first running from the blast furnace, manufactured from the following materials; viz.—

Brown rake ironstone.

Coal, denominated "Braud's Hard," used in the furnaces, without being coked.

Limestone (used indifferently) taken from the carboniferous strata at Bull Bridge and Cromford, in the neighbourhood of the Butterley Iron Works.

All the ironstone is calcined before it is used in the furnaces, and the pig iron is made by hot blast, the temperature of air introduced into the furnaces being from 500° to 600°.

CASTING.

Cast	30 September 1856.
Barometer	29·63
Thermometer	66·

Weight of—	cwts.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	19
Runners	0	2	14½
Slag and waste	0	2	12
Coals consumed	3	2	12

Time of—	hrs.	min.
Melting	0	50
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B.D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1342			1	7·134	1·299	·001	·004	·006	·007	–	–	–	·008	31,800	23,994	2·02	1·97	7·8392	·058	·004	·126	·014	–	–	·156	11,500	7,334	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1343	Mark $\frac{8}{1}$.	Slow	2	7·125	1·3	·000	·003	·004	·008	–	–	–	·009	31,500	23,732	1·99	1·98	7·8015	·056	·004	·125	·011	–	–	·152	11,600	7,434	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1344	CAST.		3	7·141	1·3	·001	·004	·006	·009	–	–	–	·009	30,000	22,601	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	·0	2·	6·5	3·	3·5	–	–	–	–	–	–	10·°
1345	30 September 1856.		1	7·155	1·3	·000	·002	·003	·006	–	–	–	·008	30,600	23,053	2·01	1·99	7·9598	·055	·003	·122	·010	–	–	·154	11,900	7,475	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1346	TESTED.	Gradual	2	7·154	1·3	·000	·003	·005	·006	–	–	–	·009	31,500	23,732	1·97	2·06	8·3598	·054	·002	·115	·010	–	–	·155	12,600	7,535	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1347	Tensile, 29 Sept. 1857. Temp. 63°.		3	7·106	1·3	·000	·002	·004	–	–	–	–	·006	29,800	22,451	–	–	–	–	–	–	–	–	–	–	–	–	1·794	3·	·0	3·	7·6	2·5	5·1	–	–	–	–	–	–	10°·5
1348			1	7·160	1·3	·000	·002	·003	·005	–	–	–	·008	30,700	23,128	1·97	2·07	8·4412	·055	·003	·119	·011	–	–	·141	11,300	6,693	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1349	Transverse, 16 July 1857. Temp. 72°.	Quick	2	7·166	1·3	·000	·001	·003	·005	–	–	–	·009	32,100	24,183	2·01	1·95	7·6430	·060	·005	·130	·012	–	–	·155	11,600	7,588	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1350	Torsion, 7 Aug. 1857.		3	7·134	1·3	·002	·004	·006	–	–	–	–	·007	29,500	22,225	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·1	·9	1·2	5·7	1·5	4·2	–	–	–	–	–	–	10°·
1351	Temp. 67°.		1	7·139	1·3	·000	·004	·007	–	–	–	–	·012	29,900	22,526	1·96	1·98	7·6839	·060	·005	·128	·014	–	–	·145	10,900	7,092	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1352	Crushing, 26 Jan. 1859.	Slow	2	7·123	1·3	·000	·003	·007	·011	–	–	–	·013	30,700	23,128	1·97	1·98	7·7231	·056	·001	·125	·010	–	–	·150	11,500	7,445	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1353	Temp. 56°.		3	7·137	1·3	·000	·004	·007	·012	–	–	–	·014	31,600	23,807	–	–	–	–	–	–	–	–	–	–	–	–	1·795	2·6	·0	2·6	6·1	2·1	4·	–	–	–	–	–	–	9°·5
1354	FRACTURE. Light Grey.		1	7·143	1·3	·000	·002	·004	–	–	–	–	·008	29,900	22,526	1·96	1·98	7·6839	·059	·005	–	–	–	–	·124	9,500	6,181	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1355	Dull.	Gradual	2	7·154	1·3	·002	·005	·008	–	–	–	–	·010	29,900	22,526	1·97	2·00	7·8800	·056	·005	·121	·010	–	–	·142	11,300	7,170	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1356	Regular. Fine Grain.		3	7·134	1·299	·000	·002	·004	–	–	–	–	·006	29,800	22,485	–	–	–	–	–	–	–	–	–	–	–	–	1·794	2·8	·0	2·8	6·4	2·1	4·3	–	–	–	–	–	–	9°·
1357	Good working qualities.		1	7·166	1·3	·001	·005	·008	·013	–	–	–	·016	34,000	25,615	1·99	2·01	8·0397	·055	·005	–	–	–	–	·120	9,300	5,783	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1358		Quick	2	7·155	1·3	·000	·004	·006	·010	–	–	–	·013	33,300	25,088	1·97	2·00	7·8800	·055	·005	·119	·010	–	–	·145	11,900	7,550	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1359			3	7·111	1·3	·000	·002	·003	·004	–	–	–	·010	32,100	24,183	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·5	·0	2·5	5·	2·	3·	–	–	–	–	–	–	7°·2
	GENERAL MEAN			7·141	1·3	·000	·003	·005	·008	–	–	–	·010	31,039	23,388	2·00	1·99	7·9202	·056	·004	·123	·011	–	–	·145	11,242	7,106	1·796	2·	·1	1·9	6·2	2·2	4·	–	–	–	–	–	–	9°·3

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 12, at the end.

IRON WORKS, NEAR ALFRETON, DERBYSHIRE.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·35
Silicon	1·27
Sulphur	0·02
Phosphorus	1·09
Manganese	1·01

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·133	23,442	7,384	7,084	83,114	10·465	3·296	3·162	37·104
1,650	7,084	35°	2·45	1·3	·6	2·16	·023	·010	·013	·046	·023	·023	-	-	-	-	-	-	-	-	23,500	83,114									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·138	23,078	7,505	7,187	88,419	10·302	3·350	3·208	39·468
1,660	7,187	35°	2·10	1·3	·6	2·16	·019	·008	·011	·041	·020	·021	·095	·070	·025	-	-	-	-	-	-	25,000	88,419									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·153	23,178	7,140	7,698	93,724	10·347	3·187	3·436	41·841
1,790	7,698	40°	1·94	1·3	·6	2·16	·017	·004	·013	·035	·013	·022	·064	·034	·030	-	-	-	-	-	-	26,500	93,724									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·133	23,153	7,268	7,434	87,711	10·336	3·244	3·318	39·156
1,720	7,434	38°	2·39	1·3	·6	2·16	·019	·003	·016	·030	·017	·013	-	-	-	-	-	-	-	-	-	24,800	87,711									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·143	22,512	6,675	6,971	85,942	10·050	2·979	3·112	38·366
1,610	6,971	37°	2·00	1·3	·6	2·16	·020	·010	·010	·048	·027	·021	-	-	-	-	-	-	-	-	-	24,300	85,942									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·144	24,962	6,666	7,681	91,955	11·143	2·975	3·429	41·051
1,780	7,681	35°	2·11	1·3	·6	2·16	·018	·003	·015	·035	·011	·024	·069	·038	·031	-	-	-	-	-	-	26,000	91,955									
1,701	7,342	36°	2·16	1·3	·6	2·16	·019	·006	·013	·039	·018	·021	·076	·047	·029	-	-	-	-	-	-	25,017	88,488	7·141	23,388	7,106	7,342	88,488	10·441	3·172	3·227	39·503
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																							7·141	23,233	7,343	7,323	88,419	10·371	3·278	3·269	39·468
																							7·140	23,542	6,870	7,362	88,536	10·509	3·066	3·286	39·525
Horizontally and Vertically cast - - - Slow - - - - -																							7·133	23,297	7,326	7,250	85,413	10·400	3·270	3·236	38·129
Gradual - - - -																							7·141	22,795	7,090	7,079	87,181	10·176	3·165	3·160	38 919
Quick - - - -																							7·149	24,070	6,903	7,689	92,840	10·745	3·081	3·432	41·446
																												Ratio in Terms of the Crushing Force - - -				·264	·080	·082	1·000

MESSRS. NEEDHAM AND COMPANY, BUTTERLEY

No. 2.—

MANUFACTURE.

Pig iron, first running from the blast furnace, manufactured from the following materials, viz :—

Brown rake ironstone.

Coal, denominated "Brand's Hard," used in the furnaces without being coked.

Limestone (used indifferently) taken from the carboniferous strata at Bull Bridge and Cromford, in the neighbourhood of the Butterley Iron Works.

All the ironstone is calcined before it is used in the furnaces, and the pig iron is made by hot blast, the temperature of air introduced into the furnaces being from 500° to 600°.

CASTING.

Cast	1 October 1856.
Barometer	29·86
Thermometer	66·

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Casting	4	0	11½
Runners	0	1	26
Slag and waste	0	1	18
Coals consumed	4	0	19

Time of—	hrs.	min.
Melting	1	0
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1360			1	7·070	1·3	·001	·003	–	–	–	–	–	·007	24,300	18,307
1361	Mark $\frac{8}{2}$.	Horizontal. Slow	2	7·080	1·3	·000	·001	–	–	–	–	–	·006	24,000	18,081
1362			3	7·073	1·3	·000	·005	–	–	–	–	–	·012	24,900	18,759
1363	CAST. 1 October 1856.		1	7·080	1·3	·000	·004	–	–	–	–	–	·009	24,000	18,081
1364		Gradual	2	7·084	1·3	·002	·006	–	–	–	–	–	·010	24,800	18,684
1365	TESTED. Tensile, 30 Sept. 1857.		3	7·060	1·3	·000	·004	–	–	–	–	–	·010	24,800	18,684
1366	Temp. 60°.		1	7·087	1·3	·002	·006	·011	–	–	–	–	·011	25,000	18,834
1367	Transverse, 17 July 1857.	Quick	2	7·107	1·3	·001	·004	–	–	–	–	–	·010	24,800	18,684
1368	Temp. 68°.		3	7·055	1·3	·003	·007	–	–	–	–	–	·012	23,500	17,705
1369	Torsion, 10 Aug. 1857. Temp. 62°.		1	7·095	1·3	·002	·005	·009	–	–	–	–	·011	25,900	19,512
1370	Crushing, 27 Jan. 1859.	Slow	2	7·085	1·3	·002	·006	·010	–	–	–	–	·012	26,000	19,588
1371	Temp. 57°.		3	7·076	1·3	·000	·002	–	–	–	–	–	·009	24,900	18,759
1372	FRACTURE.	Vertical.	1	7·073	1·3	·002	·004	·007	–	–	–	–	·010	27,300	20,567
1373	Light Grey. Bright.	Gradual	2	7·084	1·3	·001	·004	·007	–	–	–	–	·012	27,300	20,567
1374	Regular.		3	7·081	1·299	·001	·003	·007	–	–	–	–	·009	26,900	20,297
1375	Medium Grain.		1	7·088	1·3	·002	·005	·010	–	–	–	–	·012	26,400	19,889
1376	Good working qualities.	Quick	2	7·054	1·3	·003	·006	–	–	–	–	–	·008	23,500	17,705
1377			3	7·088	1·3	·002	·004	–	–	–	–	–	·010	24,900	18,759
	GENERAL MEAN			7·078	1·3	·001	·004	·009	–	–	–	–	·010	25,177	18,970

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1360	1·99	1·99	7·8805	·055	·005	–	–	–	–	·140	9,800	6,217	–	–	–	–	–	–	–	–	–	–	–	–	–
1361	1·99	1·98	7·8015	·053	·005	–	–	–	–	·140	9,800	6,280	–	–	–	–	–	–	–	–	–	–	–	–	–
1362	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·8	·8	3·	–	–	–	–	–	–	–	–	10°·
1363	1·97	2·02	8·0383	·062	·005	·140	·017	–	–	·146	10,100	6,282	–	–	–	–	–	–	–	–	–	–	–	–	–
1364	2·00	1·98	7·8408	·056	·006	–	–	–	–	·146	9,900	6,313	–	–	–	–	–	–	–	–	–	–	–	–	–
1365	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·9	·1	2·8	–	–	–	–	–	–	–	–	5°·
1366	2·00	1·99	7·9202	·060	·004	–	–	–	–	·137	9,900	6,249	–	–	–	–	–	–	–	–	–	–	–	–	–
1367	2·02	2·01	8·1610	·061	·005	–	–	–	–	·138	9,900	6,065	–	–	–	–	–	–	–	–	–	–	–	–	–
1368	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·3	1·1	2·2	–	–	–	–	–	–	–	–	6° 5
1369	1·99	1·98	7·8015	·061	·005	–	–	–	–	·119	9,200	5,896	–	–	–	–	–	–	–	–	–	–	–	–	–
1370	1·97	1·96	7·5679	·065	·005	–	–	–	–	·115	8,500	5,615	–	–	–	–	–	–	–	–	–	–	–	–	–
1371	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·4	·1	2·3	–	–	–	–	–	–	–	–	9°·0
1372	1·95	1·96	7·4911	·060	·005	–	–	–	–	·115	9,200	6,140	–	–	–	–	–	–	–	–	–	–	–	–	–
1373	1·96	1·96	7·5295	·060	·004	–	–	–	–	·194	8,000	5,312	–	–	–	–	–	–	–	–	–	–	–	–	–
1374	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·8	·1	2·7	7·	2·5	4·5	–	–	–	–	–	8°·6
1375	1·99	2·01	8·0397	·058	·004	·120	·010	–	–	·127	10,400	6,467	–	–	–	–	–	–	–	–	–	–	–	–	–
1376	2·01	2·01	8·1206	·060	·005	–	–	–	–	·125	9,900	6,095	–	–	–	–	–	–	–	–	–	–	–	–	–
1377	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·	·0	3·	–	–	–	–	–	–	–	–	6°·2
	1·99	1·99	7·8805	·059	·004	·130	·013	–	–	·128	9,550	6,077	1·7975	3·	·3	2·7	7·	2·5	4·5	–	–	–	–	–	7°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 13, at the end.

IRON WORKS, NEAR ALFRETON, DERBYSHIRE.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·74
Silicon	2·36
Sulphur	0·02
Phosphorus	1·21
Manganese	1·06

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·074	18,382	6,248	6,021	72,503	8·206	2·789	2·687	32·367
1,400	6,021	40°	2·00	1·3	·6	2·16	·022	·008	·014	·062	·040	·022	-	-	-	-	-	-	-	-	-	20,500	72,503									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·074	18,483	6,297	5,610	72,503	8·251	2·811	2·504	32·367
1,300	5,610	40°	2·15	1·3	·6	2·16	·023	·006	·017	·064	·040	·024	-	-	-	-	-	-	-	-	-	20,500	72,503									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·083	18,407	6,157	5,342	70,735	8·217	2·748	2·384	31·578
1,240	5,342	40°	2·20	1·3	·6	2·16	·025	·009	·016	·080	·057	·023	-	-	-	-	-	-	-	-	-	20,000	70,735									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·085	19,286	5,755	6,021	70,381	8·609	2·569	2·687	31·420
1,400	6,021	36°	2·08	1·3	·6	2·16	·025	·010	·015	-	-	-	-	-	-	-	-	-	-	-	-	19,900	70,381									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·079	20,477	5,726	6,709	79,577	9·141	2·556	2·995	35·525
1,560	6,709	37°	2·18	1·3	·6	2·16	·020	·007	·013	·048	·027	·021	-	-	-	-	-	-	-	-	-	22,500	79,577									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·076	18,784	6,281	6,365	82,760	8·385	2·804	2·841	36·946
1,480	6,365	39°	2·15	1·3	·6	2·16	·018	·005	·013	·036	·015	·021	-	-	-	-	-	-	-	-	-	23,400	82,760									
1,396	6,011	38°	2·12	1·3	·6	2·16	·022	·008	·014	·048	·036	·022	-	-	-	-	-	-	-	-	-	21,133	74,743	7·078	18,970	6,077	6,011	74,743	8·468	2·712	2·683	33·366
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·077	18,424	6,234	5,657	71,913	8·225	2·782	2·524	32·104
Vertical - - - -																								7·080	19,515	5,921	6,365	77,573	8·712	2·643	2·841	34·630
Horizontally and Vertically cast - - - Slow - - - - -																								7·079	18,834	6,001	6,020	71,442	8·408	2·679	2·687	31·893
Gradual - - - -																								7·077	19,480	6,011	6,159	76,040	8·696	2·683	2·749	33·946
Quick - - - -																								7·079	18,595	6,219	5,853	76,748	8·301	2·776	2·612	34·262
																													·253	·081	·080	1·000

MESSRS. NEEDHAM AND COMPANY, BUTTERLEY

No. 3.—

MANUFACTURE.

Pig iron, first running from the blast furnace, manufactured from the following materials; viz.—

Brown rake ironstone.

Coal, denominated "Brand's Hard," used in the furnaces without being coked.

Limestone (used indifferently), taken from the carboniferous strata at Bull Bridge and Cromford, in the neighbourhood of the Butterley Iron Works.

All the ironstone is calcined before it is used in the furnaces, and the pig iron is made by hot blast, the temperature of air introduced into the furnaces being from 500° to 600°.

CASTING.

Cast	1 October 1856.
Barometer	29·86
Thermometer	66°

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	20
Runners	0	2	5
Slag and waste	0	2	3
Coals consumed	3	2	12

Time of—	hrs.	min.
Melting	0	55
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	Diameter.	TENSILE. Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1378	Mark $\frac{8}{3}$. CAST. 1 October 1856. TESTED. Tensile, 1 October 1857. Temp. 60°. Transverse, 17 July 1857. Temp. 68°. Torsion, 13 Aug. 1857. Temp. 70°. Crushing, 27 Jan. 1859. Temp. 57°. FRACTURE. Light Grey. Bright. Regular. Fine Grain. Good working qualities.	Horizontal. Slow	1	7·127	1·3	·001	·003	·005	·007	–	–	–	·008	31,500	23,732	2·00	2·04	8·3232	·054	·003	·115	·010	–	–	·150	12,200	7,328	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1379			2	7·147	1·3	·000	·002	·004	·007	–	–	–	·008	31,000	23,355	2·02	2·00	8·0800	·055	·004	·112	·012	–	–	·150	12,000	7,425	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1380			3	7·106	1·3	·005	008	·012	–	–	–	–	·017	29,600	22,300	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·	·0	2·	–	–	–	–	–	–	–	–	–	4°·8
1381		Horizontal. Gradual	1	7·139	1·3	·001	·004	·005	·007	–	–	–	·009	31,100	23,430	2·03	2·01	8·2014	·055	·001	·117	·011	–	–	·132	10,500	6,401	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1382			2	7·132	1·3	·001	·004	·005	–	–	–	–	·010	29,900	22,526	2·00	2·00	8·0000	·056	·004	–	–	–	–	·120	10,000	6,250	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1383			3	7·121	1·3	·003	·005	·007	–	–	–	–	·012	29,000	22,526	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·	·3	2·7	6·2	2·8	3·4	–	–	–	–	–	–	8°·2
1384			1	7·123	1·3	·001	·004	·006	·009	–	–	–	·011	33,400	25,163	2·01	1·94	7·5648	·060	·005	·126	·014	–	–	·144	10,700	7,072	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1385		Quick	2	7·130	1·3	·001	·003	·005	·008	–	–	–	·010	32,600	24,560	1·97	2·03	8·1181	·053	·004	·115	·010	–	–	·152	12,500	7,698	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1386			3	7·115	1·3	·001	·004	·005	·007	–	–	–	·007	30,000	22,601	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·7	·0	1·7	4·3	1·1	3·2	–	–	–	–	–	–	10°·2
1387		Vertical. Slow	1	7·117	1·3	·001	·004	·005	·008	–	–	–	·009	30,400	22,902	1·97	2·00	7·8800	·055	·003	–	–	–	–	·100	9,200	5,837	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1388			2	7·128	1·3	·001	·006	·008	·011	–	–	–	·015	32,400	24,409	1·98	1·99	7·8409	·054	·002	–	–	–	–	·150	9,300	5,930	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1389			3	7·103	1·3	·000	·002	·004	·006	–	–	–	·008	31,500	23,732	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·	·0	2·	5·2	1·2	4·	–	–	–	–	–	–	8°·7
1390		Gradual	1	7·142	1·3	·000	·004	·005	·010	–	–	–	·010	30,000	22,601	2·01	2·02	8·2016	·054	·002	·15	·010	–	–	·101	11,000	6,840	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1391			2	7·142	1·3	·000	·002	·004	·005	–	–	–	·006	31,300	23,681	2·02	2·03	8·3642	·052	·002	–	–	–	–	·105	9,600	5,766	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1392			3	7·126	1·3	·002	·005	·007	–	–	–	–	·011	29,500	22,225	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·	·0	2·	5·	1·1	3·9	–	–	–	–	–	–	8°·3
1393			1	7·130	1·297	·002	·004	·006	·009	–	–	–	·010	31,300	23,690	1·98	1·99	7·8409	·056	·004	·122	·012	–	–	·138	11,000	7,014	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1394		Quick	2	7·106	1·3	·001	·004	·005	·006	–	–	–	·007	30,200	22,752	1·95	1·96	7·4911	·057	·002	·123	·013	–	–	·127	10,100	6,741	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1395			3	7·138	1·3	·000	·001	·002	·006	–	–	–	·006	30,000	22,601	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·9	·0	1·9	4·5	·6	3·9	–	–	–	–	–	–	5°·
	General Mean			7·126	1·3	·001	·004	·006	·008	–	–	–	·009	30,866	23,265	2·00	2·00	8·0000	·055	·003	·118	·011	–	–	·130	10,758	6,692	1·798	2·1	·1	2·	5·	1·3	3·7	–	–	–	–	–	–	7°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 14, at the end.

IRON WORKS, NEAR ALFRETON, DERBYSHIRE.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·71
Silicon	1·75
Sulphur	0·04
Phosphorus	1·15
Manganese	0·95

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,450	6,246	40°	2·01	1·3	·6	2·16	·020	·006	·014	·041	·019	·022	·091	·060	·031	–	–	–	–	–	–	26,000	91,955	7·126	23,129	7,376	6,246	91,955	10·325	3·292	2·788	41·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,590	6,827	42°	2·25	1·3	·6	2·16	·019	·006	·013	·041	·022	·019	–	–	–	–	–	–	–	–	–	24,800	87,711	7·130	22,827	6,325	6,827	87,711	10·190	2·823	3·047	39·156
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,780	7,655	37°	2·00	1·3	·6	2·16	·017	·003	·014	·038	·015	·023	·074	·044	·030	–	–	–	–	–	–	26,800	94,785	7·122	24,108	7,385	7,655	94,785	10·762	3·296	3·417	42·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,680	7,237	41°	2·10	1·3	·6	2·16	·019	·005	·014	·040	·018	·022	·091	·061	·030	–	–	–	–	–	–	25,200	89,126	7·116	23,681	5,883	7,237	89,126	10·572	2·626	3·230	39·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,670	7,182	36°	1·90	1·3	·6	2·16	·018	·005	·013	·039	·019	·020	·081	·053	·028	–	–	–	–	–	–	26,300	93,016	7·136	22,835	6,303	7,182	93,016	10·194	2·813	3·206	41·522
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,510	6,494	39°	1·81	1·3	·6	2·16	·018	·004	·014	·037	·014	·023	·072	·042	·030	–	–	–	–	–	–	26,400	93,370	7·124	23,014	6,877	6,494	93,370	10·274	3·070	2·899	41·683
1,613	6,940	39°	2·01	1·3	·6	2·16	·019	·005	·014	·039	·018	·021	·082	·052	·030	–	–	–	–	–	–	25,917	91,661	7·126	23,265	6,692	6,940	91,661	10·386	2·987	3·098	40·920
Combined Means - - - Slow, Gradual and Quick cooling - - -																						Horizontal - - -		7·126	23,354	7,029	6,909	91,484	10·425	3·137	3·084	40·841
																						Vertical - - - -		7·125	23,177	6,354	6,971	91,837	10·346	2·836	3·112	40·998
																						Slow - - - - -		7·121	23,405	6,629	6,741	90,541	10·448	2·959	3·000	40·419
																						Gradual - - - -		7·133	22,831	6,314	7,004	90,364	10·192	2·818	3·126	40·341
																						Quick - - - -		7·123	23,561	7,131	7,074	94,078	10·518	3·183	3·158	41·999
																						Ratio in terms of the Crushing Force - - -							·253	·073	·075	1·000

MESSRS. NEEDHAM AND COMPANY, BUTTERLEY

No. 3.—

MANUFACTURE.

Pig iron, first running from the blast furnace, manufactured from the following materials; viz.—

Blue rake ironstone.

Coal, denominated "Brand's Hard," used in the furnaces without being coked.

Limestone (used indifferently) taken from the carboniferous strata at Bull Bridge and Cromford, in the neighbourhood of the Butterley Iron Works.

All the ironstone is calcined before it is used in the furnaces, and the pig iron is made by hot blast, the temperature of air introduced into the furnaces being from 500° to 600°.

Cast	1 October 1856.
Barometer	29·86
Thermometer	66°

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Casting	3	2	9
Runners	0	3	7
Slag and Waste	0	1	19
Coals consumed	3	2	10

Time of—	hrs.	min.
Melting	0	50
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1396			1	7·154	1·3	·004	·008	·012	·015	–	–	–	·017	32,900	24,786
1397	Mark $\frac{8}{4}$.	Slow	2	7·151	1·3	·000	·003	·004	·006	·010	–	–	·011	35,800	26,971
1398	CAST.		3	7·139	1·3	·001	·004	·006	·007	–	–	–	·010	33,000	24,862
1399	1 October 1856.		1	7·134	1·297	·001	·004	·005	·007	–	–	–	·010	33,000	24,977
1400	TESTED.	Gradual	2	7·142	1·3	·001	·004	·005	·007	–	–	–	·009	31,500	23,732
1401	Tensile, 1 Oct. 1857. Temp. 60°.	Horizontal.	3	7·139	1·3	·000	·003	·005	·007	–	–	–	·008	32,400	24,409
1402			1	7·168	1·3	·002	·005	·006	·009	–	–	–	·010	31,800	23,958
1403	Transverse, 17 July 1857. Temp. 70°.	Quick	2	6·793	1·3	·002	·004	·006	·008	–	–	–	·010	33,800	25,465
1404			3	7·175	1·3	·002	·006	·009	·011	–	–	–	·012	32,800	24,711
1405	Torsion, 13 Aug. 1857. Temp. 70°.		1	7·112	1·3	·002	·005	·007	·009	–	–	–	·010	32,300	24,334
1406	Crushing, 27 Jan. 1859.	Slow	2	7·083	1·3	·001	·003	·005	·006	–	–	–	·007	31,100	23,430
1407	Temp. 57°.		3	7·031	1·3	·002	·005	·007	·010	–	–	–	·010	30,000	22,601
1408	FRACTURE.		1	6·834	1·3	·001	·004	·006	–	–	–	–	·009	29,800*	22,451*
1409	Light Grey. Bright.	Gradual	2	6·966	1·3	·002	·005	·008	–	–	–	–	·009	25,500*	19,211*
1410	Regular. Fine Grain.	Vertical.	3	7·083	1·3	·000	·003	·005	·008	–	–	–	·010	34,500*	25,992*
1411	Tolerable working qualities.		1	–	–	–	–	–	–	–	–	–	–	–	–
1412		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1413			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			7·073	1·3	·001	·004	·006	·008	·010	–	–	·010	32,013*	24,126*

TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
2·03	2·03	8·3654	·053	·004	·112	·011	–	–	·166	13,500	8,068
2·04	2·04	8·4896	·054	·005	·115	·014	–	–	·183	14,300	8,423
–	–	–	–	–	–	–	–	–	–	–	–
2·03	2·01	8·2014	·056	·005	·119	·012	–	–	·168	13,000	7,925
1·98	2·00	7·9200	·055	·005	·122	·016	–	–	·160	12,100	7,638
–	–	–	–	–	–	–	–	–	–	–	–
2·02	1·94	7·6024	·061	·005	·130	·015	–	–	·166	12,100	7,957
1·97	2·06	8·3598	·052	·002	·110	·009	–	–	·175	14,700	8,791
–	–	–	–	–	–	–	–	–	–	–	–
2·00	2·00	8·0000	·060	·004	–	–	–	–	·122	10,000*	6,250*
2·00	2·01	8·0802	·051	·003	·117	·011	–	–	·151	11,900	7,363
–	–	–	–	–	–	–	–	–	–	–	–
2·02	2·02	8·2420	·060	·005	–	–	–	–	·120	9,500*	5,762*
1·96	2·05	8·2369	·062	·005	–	–	–	–	·125	9,000*	5,463*
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
2·01	2·02	8·2016	·056	·004	·118	·012	–	–	·153	12,010*	7,364*

TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·796	–	–	–	–	–	–	–	–	–	–	–	–	2°·5
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·799	2·2	·0	2·2	–	–	–	–	–	–	–	–	–	8°·
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·799	2·1	·1	2·	5·	1·5	3·5	–	–	–	–	–	–	9°·5
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·795	2·3	·0	2·3	–	–	–	–	–	–	–	–	–	6°·7
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	2·2	·0	2·2	–	–	–	–	–	–	–	–	–	5°·5
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	2·2	·1	2·1	5·	1·5	3·5	–	–	–	–	–	–	6°·4

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 15, at the end

IRON WORKS, NEAR ALFRETON, DERBYSHIRE.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·60
Silicon	1·34
Sulphur	0·11
Phosphorus	0·75
Manganese	0·40

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameter long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·148	25,539	8,245	4,315*	98,322	11·401	3·680	1·926*	43·892
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,000*	4,315*	40°	1·77	1·3	·6	2·16	·020	·009	·011	·045	·025	·020	·088	·058	·030	-	-	-	-	-	-	27,800	98,322									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·138	24,372	7,781	6,440	94,747	10·880	3·473	2·875	42·297
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,500	6,440	36°	1·90	1·3	·599	2·17	·020	·009	·011	·045	·025	·020	·090	·062	·028	-	-	-	-	-	-	26,700	94,747									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·045	24,711	8,374	8,458	101,858	11·031	3·738	3·775	45·472
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,970	8,458	37°	2·01	1·3	·6	2·16	·019	·005	·014	·038	·015	·023	·068	·038	·030	-	-	-	-	-	-	28,800	101,858									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·075	23,455	6,806*	6,354	93,016	10·470	3·038*	2·836,	41·522
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,470	6,354	39°	2·10	1·3	·6	2·16	·021	·008	·013	·045	·025	·020	·086	·056	·030	-	-	-	-	-	-	26,300	93,016									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·961	22,551*	5,612*	6,289	97,261	10·067*	2·505*	2·807	43·420
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,460	6,289	37°	2·00	1·3	·6	2·16	·020	·007	·013	·042	·022	·020	·079	·053	·026	-	-	-	-	-	-	27,500	97,261									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,480*	6,371*	38°	1·95	1·3	·6	2·16	·020	·008	·012	·043	·022	·021	·082	·053	·029	-	-	-	-	-	-	27,420	97,041	7·073	24,126*	7,364*	6,371*	97,041	10·770*	3·287*	2·844*	43·321
																							Slow, Gradual, and Quick cooling - - - Horizontal - - - -		24,874	8,133	6,404*	98,309	11·104	3·630	2·858*	43·887
																							Slow, Gradual, and Quick cooling - - - Vertical - - - -	7·018	23,003*	6,209*	6,321	95,139	10·269*	2·771*	2·821	42·472
																							Combined Means - - - Horizontally and Vertically cast - - - Slow - - - - -	7·112	24,497	7,525*	5,334*	95,669	10·936*	3·359*	2·381*	42·709
																							Combined Means - - - Horizontally and Vertically cast - - - Gradual - - - -	7·050	23,461*	6,696*	6,364	96,014	10·474*	2·989*	2·841	42·863
																							Combined Means - - - Horizontally and Vertically cast - - - Quick - - - -	7·045	24,711	8,374	8,458	101,858	11·031	3·738	3·775	45·472
																							Ratio in terms of the Crushing Force - - -						·248	·075	·065	1·000

BUTTERLEY IRONWORKS, DERBYSHIRE.

(Messrs. Needham.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores.

The "Brown Rake" ironstone is used for the production of Nos. 1, 2, and 3 pigs. The "Blue Rake" is employed in the production of No. 4 pig sample.

Blue Rake Ironstone.—The sample forwarded from the works contained:

Phosphoric Acid - - - - - 1·46 per cent.

The *Brown Rake Ironstone*, accompanying the former, contained:

Phosphoric Acid - - - - - - 0·81 per cent.

and is identical with the ore from this district, the complete analysis of which, extracted from the Government report on "The Iron Ores of Great Britain," is here subjoined—

Brown Rake, Butterley, Derbyshire.

Protoxide of iron	37·99
Peroxide of iron	1·04
Protoxide of manganese	1·51
Alumina	0·41
Lime	4·53
Magnesia	3·30
Carbonic acid	29·92
Phosphoric acid	0·80
Bisulphide of iron	0·06
Water, hygroscopic	0·74
Water, in combination	1·47
Organic matter	1·42
Insoluble residue	16·35
	99·54

Insoluble Residue.

Silica	10·04
Alumina	5·16
Peroxide of iron	0·45
Lime	0·06
Magnesia	0·07
Potash	0·55
	16·33
Iron, Total Amount	30·60

BUTTERLEY IRON WORKS, DERBYSHIRE—*continued.*

Brand's hard coal is used as fuel without being coked;* and the limestones from Bull Bridge and Cromford employed indifferently as flux. These samples have not been subjected to chemical examination.

IRONS.

Nos. 1, 2, 3, and 4, hot blast, pig iron. As already stated, No. 4 is produced from the "Blue Rake," and the others from "Brown Rake" ironstone.

Important Constituents in 100 *Parts.*

	I.	II.	III.	IV.
Carbon, as graphite - -	3·35	2·74	2·71	2·60
Silicon - - - - -	1·27	2·36	1·75	1·34
Sulphur - - - - -	0·02	0·02	0·04	0·11
Phosphorus - - - -	1·09	1·21	1·15	0·75
Manganese - - - -	1·01	1·06	0·95	0·40

* *Remarks.*—A sample of "Hard Coal," similar to the above, from the Butterley Works, has been examined (*see* Appendix), and was found to contain—

Sulphur - - - - - - - - 0·52 per cent.

Ash - - - - - - - - 2·97 per cent.

The ash consisted of burnt shale.

The comparatively large amount of phosphorus in these samples of iron is shown to be due to the quantity of phosphoric acid in the ores employed.

MESSRS. WHITEHOUSE, WEST HALLAM

No. 1.—

MANUFACTURE.

Smelted and Manufactured with the following Materials; viz.—

Raw coal, denominated deephard
Coke made from deephard
Minerals { Black and grey rake ironstone; Honeycroft and striped rake; Limestone as a flux.

The limestone is from the carboniferous strata at Bull's Bridge and Cromford, in this neighbourhood. The whole of the ironstone is calcined before being used in the furnaces, and smelted with hot blast heated from 500° to 600°.

Cast - - - 12 September 1856.
Barometer - - - 30·18
Thermometer - - - 65°

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	3	3	5
Runners	0	3	22
Slag and Waste	1	1	1
Coals consumed	4	3	7

Time of—	hrs.	min.
Melting	0	42
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
894	Mark $\frac{1}{1}$.	Horizontal. Slow	1	7·102	1·3	·003	·006	·008	·010	–	–	–	·012	31,000	23,355
895			2	7·114	1·3	·002	·005	·008	·011	–	–	–	·011	30,000	22,601
896	CAST.		3	7·114	1·3	·002	·004	·006	–	–	–	–	·009	28,000	21,095
897	12 September 1856.	Horizontal. Gradual	1	7·103	1·3	·002	·004	·006	·008	–	–	–	·009	31,400	23,656
898	TESTED.		2	7·113	1·3	·002	·006	·010	–	–	–	–	·012	28,500	21,471
899	Tensile, 23 March 1857.		3	7·110	1·3	·003	·009	·014	–	–	–	–	·017	29,900	22,526
900	Temp. 50°.	Horizontal. Quick	1	7·118	1·3	·006	·009	·012	–	–	–	–	·014	29,900	22,526
901	Transverse, 26 Jan. 1857.		2	7·131	1·3	·000	·002	·004	·005	–	–	–	·007	30,900	23,279
902	Temp. 55°.		3	7·133	1·3	·004	·008	·012	–	–	–	–	·015	29,900	22,526
903	Torsion, 23 Mar. 1857.	Vertical. Slow	1	7·115	1·3	·002	·006	·010	–	–	–	–	·012	29,900	22,526
904	Temp. 50°.		2	7·044	1·3	·001	·005	·008	–	–	–	–	·010	28,000	21,095
905	Crushing, 28 Jan. 1859.		3	7·098	1·3	·002	·006	·009	–	–	–	–	·012	28,000	21,095
906	Temp. 56°.	Vertical. Gradual	1	7·100	1·3	·001	·005	·008	–	–	–	–	·009	25,500	19,211
907	FRACTURE.		2	7·135	1·3	·002	·006	·008	–	–	–	–	·008	25,000	18,834
908	Medium Grey. Bright. Regular. Fine Grain.		3	7·279	1·3	·000	·002	·006	·009	–	–	–	·011	31,000	23,355
909	Good working qualities.	Vertical. Quick	1	7·077	1·3	·002	·005	·008	–	–	–	–	·012	28,000	21,095
910			2	7·183	1·299	·003	·007	·010	·013	–	–	–	·017	33,900	25,579
—			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN - - -			7·121	1·3	·002	·006	·009	·009	–	–	–	·012	29,341	22,107

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
894	1·96	2·00	7·8400	·060	·000	·130	·010	–	–	·140	13,000	8,290	–	–	–	–	–	–	–	–	–	–	–	–	–
895	2·02	1·93	7·5243	·070	·005	·150	·010	–	–	·160	12,000	7,974	–	–	–	–	–	–	–	–	–	–	–	–	–
896	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·5	0·0	2·5	6·	1·0	5·	–	–	–	–	–	–	7°·5
897	2·00	1·96	7·6832	·050	·000	·120	·011	–	–	·150	12,000	7,809	–	–	–	–	–	–	–	–	–	–	–	–	–	–
898	2·00	1·99	7·9202	·060	·000	·120	·010	–	–	·180	13,000	8,206	–	–	–	–	–	–	–	–	–	–	–	–	–	–
899	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·5	0·0	2·5	5·5	1·0	4·5	–	–	–	–	–	–	6°·5
900	2·02	1·97	7·8394	·055	·000	·120	·012	–	–	·165	13,100	8,355	–	–	–	–	–	–	–	–	–	–	–	–	–	–
901	1·96	2·02	7·9975	·055	·001	·120	·010	–	–	·160	13,500	8,440	–	–	–	–	–	–	–	–	–	–	–	–	–	–
902	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·0	0·0	2·0	4·0	1·5	2·5	–	–	–	–	–	–	7°·0
903	2·04	2·15	9·4299	·040	·005	·115	·010	–	–	·150	12,600	6,680	–	–	–	–	–	–	–	–	–	–	–	–	–	–
904	2·03	2·09	8·8672	·060	·000	·112	·011	–	–	·130	12,000	6,766	–	–	–	–	–	–	–	–	–	–	–	–	–	–
905	–	–	–	–	–	–	–	–	–	–	–	–	1·798	4·0	0·0	4·0	–	–	–	–	–	–	–	–	–	6°·0
906	2·03	2·09	8·8672	·060	·002	·120	·010	–	–	·155	12,000	6,766	–	–	–	–	–	–	–	–	–	–	–	–	–	–
907	2·11	2·08	9·1287	·050	·003	·110	·010	–	–	·160	12,700	6,956	–	–	–	–	–	–	–	–	–	–	–	–	–	–
908	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·0	0·0	2·0	6·5	1·5	5·0	–	–	–	–	–	–	9°·5
909	1·99	2·00	7·9600	·060	·000	·110	·005	–	–	·130	11,500	7,223	–	–	–	–	–	–	–	–	–	–	–	–	–	–
910	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·5	0·0	3·5	6·0	0·7	5·3	–	–	–	–	–	–	12°·
—	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2·01	2·03	8·2830	·056	·001	·121	·010	–	–	·153	12491	7,58	1·798	2·7	0·0	2·7	5·6	1·1	4·5	–	–	–	–	–	–	8°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 16, at the end.

IRON WORKS, ILKESTON.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·31
Silicon	2·23
Sulphur	0·02
Phosphorus	0·72
Manganese	0·88

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,800	7,754	42°	2·05	1·3	·6	2·16	·020	·006	·014	·047	·020	·027	-	-	-	-	-	-	-	-	23,100	81,699	7·110	22,350	8,132	7,754	81,699	9·977	3·630	3·461	36·472
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,600	6,870	41°	1·98	1·3	·6	2·16	·020	·007	·013	·048	·021	·027	-	-	-	-	-	-	-	-	22,000	77,808	7·108	22,551	8,007	6,870	77,808	10·067	3·574	3·066	34·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,910	8,201	43°	0·94	1·3	·6	2·16	·016	·003	·013	·035	·011	·024	·068	·038	·030	-	-	-	-	-	27,000	95,493	7·127	22,777	8,397	8,201	95,493	10·168	3·748	3·661	42·630
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,500	6,451	40°	2·13	1·3	·6	2·16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9,000*	31,830*	7·085	21,572	6,723	6,451	31,830*	9·630	3·001	2·942	14·209*
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,600	6,881	36°	1·75	1·3	·6	2·16	·018	·006	·012	·047	·018	·029	·061	·032	·029	·109	·074	·035	-	-	30,400	107,517	7·171	20,466	6,861	6,881	107,517	9·136	3·062	3·071	47·998
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,800	7,716	40°	1·50	1·3	·6	2·16	·019	·005	·014	·040	·018	·022	·060	·034	·026	-	-	-	-	-	28,000	99,029	7·130	23,337	7,223	7,716	99,029	10·418	3·224	3·444	44·205
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,701	7,312	40°	1·72	1·3	·6	2·16	·019	·005	·014	·043	·018	·025	·063	·035	·028	·109	·074	·035	-	-	29,250*	82,229*	7·121	22,107	7,587	7,312	82,229*	9·869	3·387	3·264	36·709
Combined Means — Slow, Gradual, and Quick cooling — Horizontal																							7·115	22,559	8,179	7,608	85,000	10·070	3·651	3·396	37·946
Combined Means — Slow, Gradual, and Quick cooling — Vertical																							7·128	21,598	6,878	7,016	79,459*	9·641	3·070	3·132	35·472*
Combined Means — Horizontally and Vertically cast — Slow																							7·097	21,961	7,427	7,102	56,765*	9·804	3·315	3·170	25·341*
Combined Means — Horizontally and Vertically cast — Gradual																							7·139	21,508	7,434	6,875	92,663	9·601	3·318	3·069	41·367
Combined Means — Horizontally and Vertically cast — Quick																							7·128	23,057	7,810	7,958	97,261	10·293	3·486	3·552	43·420
Ratio in terms of the Crushing Force																												·268	·092	·088	1·000

MESSRS. WHITEHOUSE, WEST HALLAM

No. 2—

MANUFACTURE.

Smelted and Manufactured with the following Materials; viz.—

Raw coal, denominated deephard
Coke, made from deephard
Minerals: Black and grey rake ironstone; Honeycroft and striped rake; Limestone as a flux.

The limestone is from the carboniferous strata at Bull's Bridge and Cromford, in this neighbourhood. The whole of the ironstone is calcined before being used in the furnaces, and smelted with hot blast heated from 500° to 600°.

CASTING.

Cast — 12 September 1856.
Barometer — 30·18
Thermometer — 65·

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	15
Runners	0	2	4
Slag and waste	1	0	27
Coals consumed	4	2	24

Time of—	hrs.	min.
Melting	0	48
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
911			1	7·226	1·3	·002	·003	·005	·006	·007	·008	–	·011	41,900	31,567
912	Mark $\frac{1}{2}$.	Slow	2	7·232	1·3	·001	·002	·003	·004	·005	·007	–	·010	42,400	31,943
913			3	7·219	1·3	·001	·004	·006	·007	·009	·010	–	·012	44,300	33,375
	CAST.														
914	12 September 1856.		1	7·243	1·3	·000	·002	·003	·004	·005	·006	–	·007	40,500	30,512
915		Horizontal. Gradual	2	7·228	1·3	·003	·007	·009	·012	·014	–	–	·014	39,000	29,382
916	TESTED.		3	7·245	1·3	·003	·006	·009	·012	·013	·015	–	·015	40,200	30,286
	Tensile, 24 March 1857.														
917	Temp. 50°.		1	7·250	1·3	·002	·005	·008	·011	·014	–	–	·015	39,100	29,457
918	Transverse, 1 Jan. 1857.	Quick	2	7·213	1·3	·004	·007	·010	·012	·013	·015	–	·016	41,700	31,416
919	Temp. 50°.		3	7·255	1·3	·003	·006	·009	·011	·013	·014	·016	·016	45,000	33,902
	Torsion, 23 Mar. 1857.														
920	Temp. 50°.		1	7·218	1·299	·004	·006	·008	·011	·013	–	–	·019	38,000	28,673
921		Slow	2	7·236	1·3	·003	·007	·010	·012	·014	–	–	·019	37,000	27,875
922	Crushing, 28 Jan. 1859. Temp. 56°.		3	7·245	1·3	·002	·005	·008	·011	·013	–	–	·015	39,000	29,382
923	FRACTURE.		1	7·193	1·3	·003	·005	·007	·009	·012	–	–	·016	37,000	27,875
924	Medium Grey. Bright. Regular.	Vertical. Gradual	2	7·229	1·3	·001	·004	·008	·010	·011	–	–	·013	36,800	27,725
925	Fine Grain.		3	7·169	1·3	·001	·004	·007	·010	·012	–	–	·013	39,000	29,382
926	Good working qualities.		1	7·121	1·3	·003	·006	·008	·011	·013	–	–	·015	36,000	27,122
927		Quick	2	7·177	1·3	·002	·005	·007	·009	·011	–	–	·011	35,000	26,368
928			3	7·224	1·3	·003	·005	·008	·012	·015	·016	–	·017	41,000	30,889
	General Mean			7·217	1·3	·002	·005	·007	·010	·011	·011	–	·014	39,605	29,840

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	BD².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
911	2·02	2·03	8·3242	·060	·002	·120	·010	·180	·030	·210	16,900	10,151	–	–	–	–	–	–	–	–	–	–	–	–	–
912	2·00	1·96	7·6382	·050	·001	·100	·006	–	–	·175	14,000	9,110	–	–	–	–	–	–	–	–	–	–	–	–	–
913	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·6	·1	2·5	6·6	1·5	5·1	–	–	–	–	–	10°·0
914	2·00	1·95	7·6050	·050	·001	·130	·010	–	–	·180	14,500	9,533	–	–	–	–	–	–	–	–	–	–	–	–	–
915	1·96	2·03	8·0796	·058	·002	·130	·013	·160	·019	·181	15,900	9,842	–	–	–	–	–	–	–	–	–	–	–	–	–
916	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·	0·	3·	6·	1·4	4·6	–	–	–	–	–	9°·0
917	1·93	2·03	7·9533	0·60	·002	·110	·010	·160	·020	·190	16,000	10,058	–	–	–	–	–	–	–	–	–	–	–	–	–
918	2·01	1·99	7·9598	0·58	·001	·100	·015	–	–	·180	15,300	9,610	–	–	–	–	–	–	–	–	–	–	–	–	–
919	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	0·	2·	4·7	·5	4·2	7·5	1·5	6·	–	–	10°·0
920	2·05	2·06	8·6993	·063	·002	·110	·013	–	–	·132	13,000	7,471	–	–	–	–	–	–	–	–	–	–	–	–	–
921	1·99	2·11	8·8596	·045	·003	·110	·009	–	–	·160	14,800	8,352	–	–	–	–	–	–	–	–	–	–	–	–	–
922	–	–	–	–	–	–	–	–	–	–	–	–	1·799	1·5	0·	1·5	–	–	–	–	–	–	–	–	2°·0
923	2·00	2·00	8·0000	·040	·003	·115	·010	–	–	·153	14,000	8,750	–	–	–	–	–	–	–	–	–	–	–	–	–
924	1·98	2·00	7·9200	·030	·001	·120	·010	–	–	·190	15,000	9,469	–	–	–	–	–	–	–	–	–	–	–	–	–
925	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	0·	2·	5·5	1·	4·5	8·	1·5	6·5	–	–	– Index thrown off
926	2·04	2·03	8·4066	·055	·004	·120	·010	–	–	·161	14,000	8,326	–	–	–	–	–	–	–	–	–	–	–	–	–
927	1·98	2·06	8·4023	·030	·001	·126	·010	–	–	·150	13,000	7,735	–	–	–	–	–	–	–	–	–	–	–	–	–
928	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	0·	2·	5·5	1·5	4·	–	–	–	–	–	8°·0
	1·99	2·02	8·1199	·050	·002	·116	·010	·166	·023	·172	14,700	9,033	1·799	2·2	0·	2·2	5·7	1·2	4·5	7·7	1·5	6·2	–	–	8°·

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 17, at the end.

IRON WORKS, ILKESTON.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·40
Silicon	1·50
Sulphur	0·06
Phosphorus	0·34
Manganese	0·60

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·225	32,295	9,630	8,257	123,433	14·417	4·299	3·686	55·104
1,920	8,257	40°	1·90	1·3	·6	2·16	·017	·002	·015	·030	·010	·020	·050	·023	·027	·082	·047	·035	–	–	–	34,900	123,433									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·238	30,060	9,687	7,814	117,774	13·419	4·324	3·488	52·577
1,820	7,814	40°	1·94	1·3	·6	2·16	·011	·004	·007	·026	·007	·019	·043	·019	·024	·090	·050	·040	–	–	–	33,300	117,774									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·239	31,591	9,834	9,274	120,603	14·103	4·390	4·140	53·840
2,160	9,274	35°	1·20	1·3	·6	2·16	·015	·002	·013	·030	·009	·021	·049	·020	·029	·077	·041	·036	–	–	–	34,100	120,603									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·233	28,643	7,911	6,440*	118,835	12·787	3·531	2·875*	53·051
1,500 *	6,440 *	31°	1·27	1·3	·6	2·16	·018	·004	·014	·035	·015	·020	·059	·032	·027	·100	·065	·035	–	–	–	33,600	118,835									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·197	28,327	9,109	8,759	116,359	12·645	4·065	3·910	51·945
2,040	8,759	40°	2·17	1·3	·6	2·16	·012	·000	·012	·021	·006	·015	·048	·015	·033	·110	·052	·058	–	–	–	32,900	116,359									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·174	28,126	8,030	8,158	119,896	12·556	3·584	3·641	53·525
1,900	8,158	39°	2·00	1·3	·6	2·16	·016	·000	·016	·033	·010	·023	·053	·025	·028	·088	·052	·036	–	–	–	33,900	119,896									
1,890 *	8,113 *	37°	1·75	1·3	·6	2·16	·015	·002	·013	·029	·009	·020	·050	·022	·028	·091	·051	·040	–	–	–	33,783	119,483	7·217	29,840	9,033	8,113*	119,483	13·321	4·041	3·621*	53·340
																								Slow, Gradual, and Quick cooling - - - Horizontal - - -		7·234	31,315	9,717	8,448	120,603	13·979	4·337	3·771	53·840
																									7·201	28,365	8,350	7,785*	118,363	12·662	3·727	3·475*	52·839
																								Combined Means - - - Horizontally and Vertically cast - - - Slow		7·229	30,469	8,770	7,348*	121,134	13·602	3·915	3·280*	54·077
																									7·217	29,193	9,398	8,286	117,067	13·032	4·195	3·699	52·262
																								Quick - - -		7·199	29,858	8,932	8,716	120,249	13·329	3·987	3·891	53·682
																													Ratio in terms of the Crushing Force - - -				·249	·075	·067	1·000

MESSRS. WHITEHOUSE, WEST HALLAM

No. 3.—

MANUFACTURE.

Smelted and Manufactured with the following Materials; viz.—

Raw coal, denominated deephard

Coke, made from deephard

Minerals: Black and grey rake ironstone; Honeycroft and striped rake; Ironstone as a flux.

The limestone is from the carboniferous strata at Bull's Bridge and Cromford, in this neighbourhood. The whole of the ironstone is calcined before being used in the furnaces, and smelted with hot blast heated from 500° to 600°.

CASTING.

Cast — 12 September 1856.

Barometer — 30·18

Thermometer — 65°

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	24
Runners	0	0	22
Slag and waste	1	1	9
Coals consumed	3	2	2

Time of—	hrs.	min.
Melting	0	44
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
929			1	7·234	1·3	·002	·004	·006	·008	·009	·012	–	·013	40,800	30,738	2·00	1·99	7·9202	·040	·000	·090	·001	–	–	·150	13,900	8,775	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
930	Mark $\frac{1}{3}$.	Slow —	2	7·243	1·3	·001	·004	·007	·009	·011	–	–	·012	38,000	28,628	1·96	2·04	8·1567	·040	·000	·094	·001	·157	·015	·168	16,000	9,807	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
931			3	7·138	1·3	·003	·006	·008	·010	·012	–	–	·012	35,000	26,368	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	0·	2·	4·5	3·	1·5	–	–	–	–	–	–	12°·0
	CAST.																																								
932	12 September 1856.		1	7·231	1·3	·002	·004	·006	·007	·009	·011	·014	·014	45,500	34,279	2·02	2·01	8·1610	·040	·000	·093	·008	·160	·019	·169	15,500	9,496	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
933		Horizontal. Gradual	2	7·223	1·3	·002	·004	·007	·008	·011	·013	–	·013	40,000	30,135	2·01	1·95	7·6430	·041	·000	·095	·008	–	–	·153	14,000	9,158	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
934	TESTED.		3	7·250	1·3	·001	·004	·007	·009	·012	–	–	·014	39,900	30,060	–	–	–	–	–	–	–	–	–	–	–	–	1·8	1·6	0·	1·6	4·1	1·	3·1	11·	5·5	5·5	–	–	–	17°·5
	Tensile, 24 March 1857.																																								
935	Temp. 50°.		1	7·262	1·3	·003	·005	·006	·008	·010	·012	–	·013	40,900*	30,813*	2·01	1·98	7·8759	·040	·000	·088	·006	·148	·020	·168	16,600	10,532	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
936	Transverse, 26 Jan. 1857.		2	7·254	1·3	·001	·003	·006	·008	·010	·013	–	·014	41,900	31,567	1·98	2·02	8·0791	·059	·000	·110	·009	·168	·018	·178	16,900	10,458	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
937	Temp. 55°.	Quick —	3	7·268	1·3	·001	·003	·005	·008	·010	·013	–	·016	44,900	33,827	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	0·	2·	4·3	1·	3·3	–	–	–	–	–	–	6°·0
	Torsion, 20 April 1857.																																								
938	Temp. 60°.		1	7·242	1·3	·002	·004	·006	·007	·009	·011	–	·013	40, 00	30,587	2·02	2·05	8·6151	·045	·000	·097	·003	·150	·016	·160	15,500	8,995	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
939		Slow —	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
940	Crushing, 28 Jan. 1859. Temp. 56°.		3	7·238	1·3	·003	·005	·008	·010	·012	–	–	·012	35,000	26,368	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·	0·	2·	–	–	–	–	–	–	–	–	–	3·0
941			1	7·237	1·3	·002	·005	·006	·008	·009	–	–	·010	39,800	29,985	2·01	2·01	8·1206	·049	·000	·130	·008	–	–	·140	14,000	8,620	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
942	FRACTURE.	Vertical. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
943	Medium Grey. Dull. Regular.		3	7·260	1·3	·003	·005	·007	·009	·010	–	–	·012	39,600	29,834	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·	0·	2·	5·	1·	4·	–	–	–	–	–	–	8°·0
944	Fine Grain.		1	7·252	1·3	·004	·006	·007	·009	·011	·012	–	·013	41,900	31,567	2·00	2·00	8·0000	·041	·000	·090	·005	–	–	·130	14,000	8,750	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
945	Good working qualities.	Quick —	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
946			3	7·261	1·3	·004	·007	·010	·012	·014	–	–	·0 6	35,800	26,971	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·5	0·	1·5	3·5	0·	3·5	–	–	–	–	–	–	5°·0
	GENERAL MEAN			7·239	1·3	·002	·005	·007	·009	·011	·012	·014	·013	39,973*	30,115*	2·00	2·01	8·0802	·044	·000	·098	·005	·156	·017	·157	15,155	9,399	1·798	1·8	0·	1·8	4·3	1·2	3·1	11·	5·5	5·5	–	–	–	8°·6

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 18, at the end.

IRON WORKS, ILKESTON.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·60
Silicon	1·26
Sulphur	0·05
Phosphorus	0·72
Manganese	0·45

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·205	28,578	9,291	8,587	110,700	12·758	4·147	3·833	49·419
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
2,000	8,587	38°	2·23	1·3	·6	2·16	·016	·000	·016	·033	·010	·023	·055	·028	·027	·100	·065	·035	-	-	-	31,300	110,700									
-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·234	31,491	9,327	9,773	118,481	14·055	4·163	4·362	52·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
2,280	9,773	40°	1·14	1·3	·6	2·16	·010	·000	·010	·020	·002	·018	·040	·011	·029	·079	·038	·041	-	-	-	33,500	118,481									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·261	32,069*	10,495	7,729*	134,397	14·316*	4·685	3·450*	59·998
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,800*	7,729*	40°	2·15	1·3	·6	2·16	·015	·001	·014	·028	·008	·020	·045	·016	·029	·065	·030	·035	·100	·055	·045	38,000	134,397									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·240	28,477	8,995	6,451*	117,139	12·712	4·015	2·879	52·281
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,500*	6,451*	40°	1·85	1·3	·598	2·17	·018	·003	0·15	·035	·014	·021	·058	·030	·028	·098	·063	·035	-	-	-	32,900	117,139									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·248	29,909	8,620	7,970	118,835	13·352	3·848	3·558	53·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,850	7,970	40°	2·16	1·3	·6	2·16	·011	·000	·011	·023	·008	·015	·045	·017	·028	·080	·050	·030	-	-	-	33,600	118,835									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·256	29,269	8,750	7,327	122,372	13·066	3·906	3·270	54,630
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,700	7,327	40°	1·67	1·3	·6	2·16	·015	·000	·015	·030	·006	·024	·045	·018	·027	·070	·036	·034	-	-	-	34,600	122,372									
1,855*	7,973*	39°	1·86	1·3	·6	2·16	·014	·001	·013	·028	·008	·020	·048	·020	·028	·082	·047	·035	·100	·055	·045	33,983	120,321	7·239	30,115*	9,399	7,973*	120,321	13·444*	4·196	3·559*	53·714
Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - -																							7·233	30,712*	9,704	8,696*	121,193	13·710*	4·322	3·882*	54·102
Combined Means - - - Slow, Gradual, and Quick cooling - - - Vertical - - - -																							7·248	29,218	8,788	7,249*	119,449	13·043	3·923	3·236*	53·325
Combined Means - - - Horizontally and Vertically cast - - - Slow - - - - -																							7·222	28,527	9,143	7,519*	113,919	12·735	4·081	3·356*	50·856
Combined Means - - - Horizontally and Vertically cast - - - Gradual - - - -																							7·241	30,700	8,973	8,871	118,658	13·705	4·005	3·960	52·972
Combined Means - - - Horizontally and Vertically cast - - - Quick - - - -																							7·258	30,669*	9,622	7,525*	128,385	13·691*	4·295	3·359*	57·314
																												·250	·078	·066	1·000

MESSRS. WHITEHOUSE, WEST HALLAM

GREY

MANUFACTURE.

Smelted and Manufactured with the following Materials: viz.—
Raw coal, denominated deephard
Coke, made from deephard
Minerals { Black and grey rake ironstone; Honeycroft and striped rake; Limestone as a flux.

The limestone is from the carboniferous strata at Bull's Bridge and Cromford, in this neighbourhood. The whole of the ironstone is calcined before being used in the furnaces, and smelted with hot blast heated from 500° to 600°.

Cast — 16 September 1856.
Barometer — 30·16
Thermometer — 62°

CASTING.

Weight of—	cwts.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	24
Runners	0	0	25½
Slag and waste	0	2	12
Coals consumed	4	2	2

Time of—	hrs.	min.
Melting	0	40
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
947	Mark $\frac{1}{4}$.	Horizontal. Slow	1	7·173	1·3	·001	·004	·006	·010	·014	–	–	·014	35,000	26,368
948			2	7·165	1·3	·003	·006	·008	·012	·015	–	–	·016	36,500	27,499
949	CAST.		3	7·184	1·3	·003	·005	·007	·009	·012	–	–	·014	37,500	28,252
950	16 September 1856.		1	7·159	1·3	·002	·005	·008	·011	·013	–	–	·013	35,000	26,368
951	TESTED.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
952	Tensile, 25 March 1857. Temp. 54°.		3	7·166	1·3	·002	·004	·007	·009	·010	–	–	·011	39,000	29,382
953			1	7·175	1·3	·002	·004	·006	·008	·012	–	–	·012	39,000	29,382
954	Transverse, 27 Jan. 1857. Temp. 54°.	Quick	2	7·156	1·3	·004	·006	·008	·011	·014	–	–	·016	36,100	27,197
955			3	7·165	1·3	·003	·005	·007	·009	–	–	–	·010	34,000	25,615
956	Torsion, 20 April 1857. Temp. 60°.		1	7·160	1·3	·004	·006	·008	·009	–	–	–	·010	33,000	24,861
957	Crushing, 28 Jan. 1859.	Slow	2	7·160	1·3	·003	·006	·009	·013	–	–	–	·016	31,000	23,355
958	Temp. 56°.		3	7·165	1·3	·001	·004	·007	·010	–	–	–	·011	31,900	24,033
959	FRACTURE. Light Grey.	Vertical.	1	7·148	1·3	·001	·004	·007	·009	–	–	–	·011	34,300	25,841
960	Bright.	Gradual	2	7·161	1·3	·002	·005	·008	–	–	–	–	·010	29,000	21,848
961	Regular. Fine Grain.		3	7·170	1·3	·003	·006	·009	·011	–	–	–	·011	30,000	22,601
962	Good working qualities.		1	7·124	1·3	·001	·003	·005	·008	–	–	–	·009	30,800	23,204
963		Quick	2	7·237	1·3	·003	·006	·009	·011	–	–	–	·013	30,600	23,053
964			3	7·165	1·3	·001	·004	·006	·008	–	–	–	·008	30,000	22,601
	GENERAL MEAN			7·166	1·3	·002	·005	·007	·010	·013	–	–	·012	33,688	25,380

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
947	1·99	2·05	8·3629	·040	·000	·110	·003	–	–	·129	12,000	7,174	–	–	–	–	–	–	–	–	–	–	–	–	–
948	2·01	2·00	8·0400	·050	·000	·111	·003	–	–	·140	12,100	7,524	–	–	–	–	–	–	–	–	–	–	–	–	–
949	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	0·	2·	5·5	2·	3·5	–	–	–	–	–	–	8°·5
950	1·98	2·02	8·0791	·050	·000	·112	·008	–	–	·151	12,600	7,797	–	–	–	–	–	–	–	–	–	–	–	–	–	–
951	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
952	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·	0·	2·	5·	1·5	3·5	–	–	–	–	–	–	7°·0
953	2·02	1·99	7·9994	·055	·000	·112	·006	–	–	·150	12,800	8,000	–	–	–	–	–	–	–	–	–	–	–	–	–	–
954	1·96	2·03	8·0769	·052	·000	·115	·008	–	–	·158	13,100	8,298	–	–	–	–	–	–	–	–	–	–	–	–	–	–
955	–	–	–	–	–	–	–	–	–	–	–	–	1·799	1·8	0·	1·8	4·5	1·	3·5	–	–	–	–	–	–	10°·0
956	1·98	1·99	7·8409	·054	·000	·117	·008	–	–	·135	11,400	7,269	–	–	–	–	–	–	–	–	–	–	–	–	–	–
957	1·99	1·96	7·6447	·050	·000	·110	·007	–	–	·140	11,800	7,717	–	–	–	–	–	–	–	–	–	–	–	–	–	–
958	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·	0·	3·	5·	1·	4·	–	–	–	–	–	–	8°·0
959	1·96	1·96	7·5295	·052	·000	·117	·010	–	–	·145	12,300	8,167	–	–	–	–	–	–	–	–	–	–	–	–	–	–
960	1·97	1·97	7·6453	·052	·000	·113	·007	–	–	·150	12,500	8,174	–	–	–	–	–	–	–	–	–	–	–	–	–	–
961	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	0·	2·	5·	1·	4·	–	–	–	–	–	–	8°·5
962	1·95	1·95	7·4148	·051	·000	·117	·007	–	–	·139	11,700	7,889	–	–	–	–	–	–	–	–	–	–	–	–	–	–
963	1·97	1.97	7·6453	·053	·000	·116	·009	–	–	·125	11,100	7,259	–	–	–	–	–	–	–	–	–	–	–	–	–	–
964	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·6	0·	1·6	4·5	1·	3·5	–	–	–	–	–	–	8°·0
	1·98	1·99	7·8409	·051	·000	·114	·007	–	–	·142	12,127	7,751	1·799	2·1	0·	2·1	4·9	1·2	3·7	–	–	–	–	–	–	8°·3

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 19, at the end.

IRON WORKS, ILKESTON.

FORGE..

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·74
Silicon	1·41
Sulphur	0·03
Phosphorus	0·95
Manganese	0·89

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·174	27,373	7,349	7,428	94,078	12·220	3·280	3·316	41·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,730	7,428	38°	2·16	1·3	·6	2·16	·017	·003	·014	·035	·014	·021	·068	·040	·028	-	-	-	-	-	-	26,600	94,078									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·162	27,875	7,797	7,065	102,212	12·444	3·480	3·154	45·629
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,640	7,065	40°	2·07	1·3	·6	2·16	·011	·002	·009	·024	·012	·012	·043	·012	·031	-	-	-	-	-	-	28,900	102,212									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·165	27,398	8,149	8,373	103,005	12·231	3·637	3·737	45·984
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,950	8,373	30°	1·39	1·3	·597	2·17	·016	·002	·014	·032	·011	·021	·056	·028	·028	-	-	-	-	-	-	28,900	103,005									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·161	24,083	7,493	7,759	95,493	10·751	3·345	3·463	42·629
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,810	7,759	36°	1·21	1·3	·6	2·16	·019	·005	·014	·039	·018	·021	·075	·046	·029	-	-	-	-	-	-	27,000	95,493									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·159	23,430	8,170	7,771	99,029	10·459	3·647	3·469	44·205
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,810	7,771	37°	2·13	1·3	·6	2·16	·010	·003	·007	·020	·003	·017	·039	·011	·028	-	-	-	-	-	-	28,000	99,029									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·175	22,953	7,574	7,870	101,339	10·246	3·381	3·513	45·236
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,830	7,870	36°	1·92	1·3	·591	2·19	·015	·002	·013	·034	·011	·023	·063	·032	·031	-	-	-	-	-	-	27,800	101,339									
1,795	7,711	38°	1·81	1·3	·598	2·17	·015	·003	·012	·031	·012	·019	·057	·028	·029	-	-	-	-	-	-	27,867	99,193	7·166	25,380	7,751	7,711	99,193	11·330	3·460	3·442	44·281
Combined Means — Slow, Gradual and Quick cooling — Horizontal																								7·167	27,507	7,758	7,622	99,765	12·279	3·463	3·402	44·508
Combined Means — Slow, Gradual and Quick cooling — Vertical																								7·165	23,488	7,746	7,800	98,620	10·485	3·458	3·482	44·026
Combined Means — Horizontally and Vertically cast — Slow																								7·167	25,728	7,421	7,593	94,786	11·485	3·312	3·389	42·315
Combined Means — Horizontally and Vertically cast — Gradual																								7·161	25,652	7,983	7,418	100,621	11·451	3·563	3·311	44·915
Combined Means — Horizontally and Vertically cast — Quick																								7·170	25,175	7,861	8,121	102,172	11·238	3·509	3·625	45·611
																													·255	·078	·078	1·000

Ratio in Terms of the Crushing Force - - -

MESSRS. WHITEHOUSE, WEST HALLAM

No. 4.—

MANUFACTURE.

Smelted and Manufactured with the following Materials; viz.—

Raw coal, denominated deephard - - - - - - - - - - 1/3
Coke made from deephard - - - - - - - - - - 1/3
Minerals { Black and grey ironstone - - - - - - - - - 1/3
Honeycroft and striped rake - - - - - - - - - 1/3
Limestone as a flux.

The limestone is from the carboniferous strata at Bull's Bridge and Cromford, in this neighbourhood. The whole of the ironstone is calcined before being used in the furnaces, and smelted with hot blast heated from 500° to 600°.

CASTING.

Cast - - 16 September 1856.
Barometer - - - 30·16
Thermometer - - - 62°

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	4	0	14
Runners - -	0	1	25
Slag and waste	0	2	1
Coals consumed	3	3	4

Time of—	hrs.	min.
Melting - - -	0	40
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
965			1	7·094	1·3	·002	·005	–	–	–	–	–	·008	24,500	18,458
966	Mark $\frac{1}{5}$*	Slow -	2	7·123	1·3	·002	·005	–	–	–	–	–	·008	24,000	18,081
967			3	7·070	1·3	·002	·005	–	–	–	–	–	·009	23,300	17,554
968	CAST. 16 September 1856.		1	7·122	1·3	·001	·005	·010	–	–	–	–	·012	26,700	20,115
969		Horizontal. Gradual	2	7·132	1·3	·002	·004	·006	–	–	–	–	·008	27,300	20,567
970	TESTED. Tensile, 26 March 1857.		3	7·138	1·3	·003	·004	·007	–	–	–	–	·008	27,300	20,567
971	Temp. 55°.		1	7·075	1·3	·003	·006	·008	–	–	–	–	·012	26,300	19,814
972	Transverse, 27 Jan. 1857.	Quick -	2	7·117	1·3	·002	·005	·008	–	–	–	–	·011	27,800	20,944
973	Temp. 54°.		3	7·122	1·3	·003	·005	·007	–	–	–	–	·009	28,900	21,773
974	Torsion, 20 April 1857. Temp. 60°.		1	7·121	1·3	·002	·006	·010	–	–	–	–	·012	25,100	18,909
975		Slow -	2	7·115	1·3	·002	·005	·008	–	–	–	–	·010	25,100	18,909
976	Crushing, 28 Jan. 1859. Temp. 56°.		3	7·124	1·3	·002	·005	·008	–	–	–	–	·010	26,500	19,965
977	FRACTURE. Medium Grey. Bright. Regular. Fine Grain.		1	7·138	1·3	·001	·003	·006	–	–	–	–	·009	27,900	21,019
978		Vertical. Gradual	2	7·138	1·3	·000	·003	·006	–	–	–	–	·006	25,000	18,834
979			3	7·136	1·3	·003	·006	·010	–	–	–	–	·012	27,800	20,944
980	Good working qualities.		1	7·093	1·3	·001	·004	·007	–	–	–	–	·009	26,900	20,266
981		Quick -	2	7·121	1·3	·003	·006	·010	–	–	–	–	·010	25,000	18,834
982			3	7·129	1·3	·002	·004	·006	–	–	–	–	·009	28,800	21,698
	GENERAL MEAN - - -			7·117	1·3	·002	·005	·008	–	–	–	–	·010	26,344	19,847

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
965	2·03	2·00	8·1200	·055	·001	·133	·012	–	–	·162	11,800	7,266	–	–	–	–	–	–	–	–	–	–	–	–	–
966	1·98	2·06	8·4023	·056	·002	·130	·013	–	–	·185	12,600	7,497	–	–	–	–	–	–	–	–	–	–	–	–	–
967	–	–	–	–	–	–	–	–	–	–	–	–	1·799	1·	0·	1·	9·	3·	6·	–	–	–	–	–	–	9°·0
968	1·99	1·95	7·5669	·061	·001	·139	·016	–	–	·200	12,900	8,523	–	–	–	–	–	–	–	–	–	–	–	–	–	–
969	1·95	2·04	8·1151	·055	·000	·130	·010	–	–	·180	12,500	7,701	–	–	–	–	–	–	–	–	–	–	–	–	–	–
970	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·7	0·	2·7	8·	3·3	4·7	–	–	–	–	–	–	9°·2
971	2·02	1·98	7·9192	·059	·002	·136	·012	–	–	·179	11,900	7,513	–	–	–	–	–	–	–	–	–	–	–	–	–	–
972	2·02	1·96	7·7600	·055	·000	·132	·010	–	–	·174	12,000	7,731	–	–	–	–	–	–	–	–	–	–	–	–	–	–
973	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·5	0·	2·5	7·	1·5	5·5	–	–	–	–	–	–	9°·0
974	1·97	1·97	7·6453	·060	·002	–	–	–	–	·130	10,000	6,539	–	–	–	–	–	–	–	–	–	–	–	–	–	–
975	1·96	1·96	7·5295	·070	·001	–	–	–	–	·135	10,000	6,640	–	–	–	–	–	–	–	–	–	–	–	–	–	–
976	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·	0·	3·	–	–	–	–	–	–	–	–	–	6°·0
977	1·96	1·99	7·7617	·056	·001	·130	·010	–	–	·142	10,700	6,892	–	–	–	–	–	–	–	–	–	–	–	–	–	–
978	1·98	1·99	7·8409	·058	·002	·130	·013	–	–	·149	11,300	7,205	–	–	–	–	–	–	–	–	–	–	–	–	–	–
979	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·6	0·	3·6	–	–	–	–	–	–	–	–	–	8°·0
980	1·96	1·97	7·6065	·060	·002	–	–	–	–	·130	10,000	6,573	–	–	–	–	–	–	–	–	–	–	–	–	–	–
981	1·95	1·96	7·4911	·058	·008	–	–	–	–	·146	9,000	6,007	–	–	–	–	–	–	–	–	–	–	–	–	–	–
982	–	–	–	–	–	–	–	–	–	–	–	–	1·800	3·5	0·	3·5	9·	5·	4·	–	–	–	–	–	–	11°·0
	1·98	1·99	7·8409	·059	·002	·132	·012	–	–	·159	11,225	7,173	1·799	2·7	0·	2·7	8·2	3·2	5·	–	–	–	–	–	–	8°·7

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 20, at the end.

IRON WORKS, ILKESTON.

STRONG FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·57
Silicon	1·53
Sulphur	0·05
Phosphorus	0·70
Manganese	0·94

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	7·095	18,031	7,381	6,440	73,564	8·049	3·295	2·875	32·839
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-									
1,500	6,440	35°	2·06	1·3	·6	2·16	·025	·010	·015	·059	·036	·023	-	-	-	-	-	-	-	-	-	20,800	73,564									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	7·130	20,416	8,112	6,709	77,808	9·118	3·620	2·995	34·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-									
1,560	6,709	45°	2·20	1·3	·6	2·16	·022	·011	·011	·055	·037	·018	-	-	-	-	-	-	-	-	-	22,000	77,808									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	7·104	20,843	7,622	6,913	81,345	9·304	3·402	3·086	36·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-									
1,610	6,913	42°	2·06	1·3	·6	2·16	·019	·003	·016	·040	·019	·021	-	-	-	-	-	-	-	-	-	23,000	81,345									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	7·120	19,261	6,589	5,582	67,198	8·598	2·941	2·491	29·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-									
1,300	5,582	40°	1·86	1·3	·6	2·16	·028	·012	·016	-	-	-	-	-	-	-	-	-	-	-	-	19,000	67,198									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	7·137	20,265	7,048	6,311	79,577	9·046	3·146	2·817	35·525
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-									
1,470	6,311	42°	1·99	1·3	·6	2·16	·015	·008	·007	·049	·015	·034	-	-	-	-	-	-	-	-	-	22,500	79,577									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	7·114	20,266	6,290	6,472	72,415	9·047	2·808	2·889	32·328
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-									
1,510	6,472	35°	1·86	1·3	·593	2·19	·026	·011	·015	·070	·040	·030	-	-	-	-	-	-	-	-	-	20,000	72,415									
1,491	6,403	40°	2·00	1·3	·599	2·17	·023	·009	·014	·055	·029	·026	-	-	-	-	-	-	-	-	-	21,216	75,318	7·117	19,847	7,173	6,403	75,318	8·360	3·202	2·858	33·624
Combined Means - - - Slow, Gradual and Quick cooling - - Horizontal - - -																								7·110	19,763	7,705	6,684	77,572	8·822	3·439	2·983	34·630
Vertical - - - -																								7·124	19,930	6,642	6,121	73,063	8·897	2·965	2·732	32·617
Horizontally and Vertically cast - - - Slow - - - - -																								7·108	18,646	6,985	6,011	70,381	8·324	3·118	2·683	31·420
Gradual - - - -																								7·134	20,340	7,580	6,510	78,693	9·080	3·383	2·905	35·130
Quick - - - -																								7·109	20,554	6,956	6,697	76,880	9·175	3·105	2·989	34·321
																													·263	·095	·085	1·000

WEST HALLAM IRON WORKS, ILKESTON, DERBYSHIRE.

(Mr. H. B. Whitehouse.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

No samples of the raw materials employed at the West Hallam Works have been received. The ores stated to be used are black and grey rake ironstone, honeycroft and striped rake, in the proportion of two-thirds of the former and one-third of the latter. The fuel employed consists, one-third of raw coal "deep hard" and two-thirds of coke made from that coal.

The examination of several specimens of the ores of this district has shown that they contain a somewhat high per-centage of phosphoric acid (from 0·8 to 1·5). This probably accounts for the quantity of phosphorus found in the majority of the samples of Ilkeston iron.

Irons.

Important Constituents in 100 *Parts.*

	I. No. 1. Foundry Pig.	II. No. 2. Foundry Pig.	III. No. 3. Foundry Pig.	IV. Grey Forge.	V. No. 4. Strong Forge.
Carbon, as graphite	2·31	2·40	2·60	2·74	2·57
Silicon - -	2·23	1·50	1·26	1·41	1·53
Sulphur - -	0·02	0·06	0·05	0·03	0·05
Phosphorus -	0·72	0·34	0·72	0·95	0·70
Manganese -	0·88	0·60	0·45	0·89	0·94

GOLDENDALE IRON WORKS,

NEAR STOKE-UPON-TRENT, STAFFORDSHIRE.

(Mr. W. S. Williamson.)

MESSRS. WILLIAMSON, GOLDENDALE

PIG

CASTING.

Cast - - - 10 October 1856.
Barometer - - - 30·24
Thermometer - - - 64·

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Casting - -	3	1	17
Runners - -	0	1	25
Slag and Waste -	0	1	26
Coals consumed -	4	2	13

Time of—	hrs.	min.
Melting - - -	1	2
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting - -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1756	Mark $\frac{17}{1}$.	Horizontal. Slow -	1	7·056	1·3	·001	·003	·004	·006	–	–	–	·007	32,000	24,108
1757			2	7·048	1·290	·002	·005	·006	·008	–	–	–	·009	31,200	23,542
1758	CAST.		3	7·055	1·3	·001	·003	·005	·006	–	–	–	·007	32,500	24,485
1759	10 October 1856.		1	7·085	1·3	·001	·003	·005	·006	–	–	–	·007	34,800	26,218
1760	TESTED.		2	7·084	1·295	·000	·003	·004	·006	–	–	–	·007	34,900	26,496
1761	Tensile, 1 Feb. 1858.	Gradual	3	7·065	1·3	·000	·002	·004	·005	·006	–	–	·007	35,700	26,895
	Temp. 56°.														
1762			1	7·113	1·3	·001	·003	·006	·007	–	–	–	·008	34,800	26,218
1763	Transverse, 28 Oct. 1857.		2	7·134	1·3	·000	·003	·005	·006	–	–	–	·007	32,500	24,485
1764	Temp. 59°.	Quick -	3	7·136	1·3	·001	·002	·004	·005	·007	–	–	·008	35,700	26,895
	Torsion, 24 Nov. 1857.														
1765	Temp. 56°.		1	7·033	1·3	·001	·002	·004	·005	–	–	–	·006	31,200	23,506
1766	Crushing, 27 Jan. 1859.	Slow -	2	7·125	1·3	·000	·002	·004	·005	–	–	–	·006	33,400	25,163
1767	Temp. 57°.		3	7·117	1·3	·001	·003	·005	·006	·009	–	–	·012	35,900	27,046
1768	FRACTURE.	Vertical.	1	7·126	1·3	·004	·005	·007	·009	–	–	–	·011	32,300	24,334
1769	Light Grey Bluish.		2	7·121	1·3	·001	·003	·004	·005	–	–	–	·005	34,900	26,293
1770	Dull.	Gradual	3	7·149	1·3	·000	·003	·004	·005	–	–	–	·007	34,200	25,766
	Regular.														
1771	Fine Grain.		1	–	–	–	–	–	–	–	–	–	–	–	–
1772	Tolerable working qualities.	Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–
1773			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN - - -			7·096	1·3	·001	·003	·005	·006	·007	–	–	·008	33,733	25,430

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1756	2·03	1·98	7·9584	·047	·000	·144	·002	–	–	·147	12,600	7,916	–	–	–	–	–	–	–	–	–	–	–	–	–
1757	2·00	1·97	7·7618	·055	·003	·110	·007	–	–	·138	12,200	7,859	–	–	–	–	–	–	–	–	–	–	–	–	–
1758	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·0	·0	2·0	3·5	1·1	2·4	–	–	–	–	–	5°·3
1759	2·00	2·01	8·0802	·055	·004	·107	·008	–	–	·146	13,500	8,353	–	–	–	–	–	–	–	–	–	–	–	–	–
1760	2·02	2·04	8·4064	·050	·003	·104	·009	–	–	·152	14,500	8,624	–	–	–	–	–	–	–	–	–	–	–	–	–
1761	–	–	–	–	–	–	–	–	–	–	–	–	1·798	8·0	·0	8·0	–	–	–	–	–	–	–	–	2°·5
1762	2·03	1·96	7·7984	·045	·000	·099	·001	–	–	·104	10,200	6,539	–	–	–	–	–	–	–	–	–	–	–	–	–
1763	2·02	1·95	7·6810	·056	·003	·103	·002	–	–	·133	11,500	7,485	–	–	–	–	–	–	–	–	–	–	–	–	–
1764	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·0	·0	1·0	–	–	–	–	–	–	–	–	2°·4
1765	1·93	1·99	7·8409	·045	·000	·102	·001	–	–	·112	10,800	6,886	–	–	–	–	–	–	–	–	–	–	–	–	–
1766	1·97	2·01	7·9589	·045	·000	·100	·001	–	–	·135	12,900	8,104	–	–	–	–	–	–	–	–	–	–	–	–	–
1767	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·7	·0	1·7	3·4	0·1	3·3	–	–	–	–	–	6°·0
1768	1·95	1·96	7·4911	·056	·002	·116	·008	–	–	·138	11,500	7,675	–	–	–	–	–	–	–	–	–	–	–	–	–
1769	1·95	1·94	7·3390	·056	·004	–	–	–	–	·118	9,500	6,472	–	–	–	–	–	–	–	–	–	–	–	–	–
1770	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·8	·0	1·8	3·2	0·1	3·1	–	–	–	–	–	6°·2
1771	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1772	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1773	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1·99	1·98	7·8015	·051	·001	·099	·004	–	–	·132	11,920	7,591	1·797	1·4	·0	1·4	3·3	0·4	2·9	–	–	–	–	–	4°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 21. at the end.

IRON WORKS, STAFFORDSHIRE.

IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·54
Silicon	2·71
Sulphur	0·04
Phosphorus	1.07
Manganese	0·98

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·053	24,045	7,887	7,539	102,919	10·734	3·520	3·365	45·945
1,750	7,539	41°	2·22	1·3	·6	2·16	·016	·001	·015	·029	·006	·023	·051	·022	·029	–	–	–	–	–	–	29,100	102,919									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·078	26,536	8,488	5,591	122,018	11·846	3·789	2·495	54·472
1,300	5,591	35°	1·60	1·3	·6	2·16	·015	·000	·015	·025	·002	·023	·039	·010	·029	·060	·023	·037	–	–	–	34,500	122,018									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·127	25,866	7,012	5,376	118,128	11·547	3·130	2·400	52·735
1,250	5,376	32°	1·96	1·3	·6	2·16	·015	·001	·014	·025	·003	·022	·040	·011	·029	·065	·030	·035	–	–	–	33,400	118,128									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·091	25,238	7,495	7,582	111,761	11·266	3·345	3·384	49·893
1,760	7,582	40°	1·42	1·3	·6	2·16	·015	·001	·014	·027	·005	·022	·045	·017	·018	·081	·047	·034	–	–	–	31,600	111,761									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·132	25,464	7,073	8,099	112,469	11·367	3·157	3·615	50·209
1,880	8,099	36°	1·40	1·3	·6	2·16	·015	·001	·014	·026	·004	·022	·045	·015	·030	·079	·043	·036	–	–	–	31,800	112,469									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,588	6,837	37°	1·72	1·3	·6	2·16	·015	·001	·014	·026	·004	·022	·044	·015	·029	·071	·036	·035	–	–	–	32,080	118,459	7·096	25,430	7,591	6,837	113,459	11·352	3·388	3·052	50·651
Combined Means	Slow, Gradual, and Quick cooling	Horizontal																					7·086	25,482	7,796	6,168	114,355	11·375	3·480	2·753	51·051
		Vertical																					7·112	25,351	7,284	7,840	112,115	11·317	3·251	3·500	50·051
	Horizontally and Vertically cast	Slow																					7·072	24,641	7,691	7,560	107,340	11·000	3·433	3·375	47·919
		Gradual																					7·105	26,000	7,780	6,845	117,244	11·607	3·473	3·055	52·341
		Quick																					7·127	25,866	7,012	5,376	118,128	11·547	3·130	2·400	52·735
																												Ratio in terms of the Crushing Force			·223	·066	·060	1·000

497·

GOLDENDALE IRON WORKS, NEAR STOKE-UPON-TRENT, STAFFORDSHIRE.

(MR. W. S. WILLIAMSON.)

CHEMICAL REPORT on the IRON, and MATERIALS employed in its Manufacture.

ORE.

Clay ironstone, from the chalky mine; dark grey; minutely crystalline in structure; homogeneous.

Protoxide of iron	45·71
Oxide of manganese	1·20
Lime	3·37
Magnesia	1·93
Carbonic acid	33·50
Phosphoric acid	1·42
Bisulphide of iron	0·13
Water	2·64
Organic matter	trace.
Clay, ignited	9·66
	99·56
Metallic iron	35·55

FUEL.

"*Coal* from North Wales." The sample was too small to give any reliable results on chemical examination.

FLUX.

Froghall limestone, light coloured, crystalline.

(Sample dried at 212° Fahrenheit.)

Carbonate of lime	97·89
Carbonate of magnesia	0·87
Carbonate of iron	0·48
Carbonate of manganese	traces.
Phosphate of lime	
Silica (sand)	0·63
	99·87

GOLDENDALE IRON WORKS, NEAR STOKE-UPON-TRENT, STAFFORDSHIRE—*continued.*

IRON.

One specimen only was received.

Important Constituents in 100 *Parts.*

Carbon, as graphite - - - - -	2·54
Silicon - - - - - - - -	2·71
Sulphur - - - - - - - -	0·04
Phosphorus - - - - - - -	1·07
Manganese - - - - - - -	0·98

Remark.—The somewhat considerable amount of phosphorus in this sample of iron, corresponds with the high per-centage of phosphoric acid in the ore employed.

MESSRS. GRAZEBROOK, NETHERTON

No. 1.—

MANUFACTURE.

First running from the cold-blast furnace, smelted with coke made from the best coal for smelting iron.

The whole of the ironstone and coke obtained from the mines of Messrs. Grazebrook, adjacent to the works.

CASTING.

Cast - - - 16 September 1856.
Barometer - - - 30·16
Thermometer - - - 62°

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	4	0	17
Runners - -	0	2	11
Slag and waste -	1	0	2
Coals consumed	4	3	6

Time of—	hrs.	min.
Melting - - -	0	33
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
983			1	7·127	1·3	·002	·005	·008	–	–	–	–	·010	26,000	19,588
984	Mark $\frac{2}{1}$.	Slow -	2	7·135	1·3	·004	·008	–	–	–	–	–	·009	25,000	18,834
985			3	7·130	1·3	·004	·007	·009	–	–	–	–	·009	26,100	19,663
	CAST.														
986	16 September 1856.		1	7·117	1·3	·003	·008	–	–	–	–	–	·009	24,000	18,081
987		Horizontal. Gradual	2	7·113	1·3	·002	·006	–	–	–	–	–	·010	24,000	18,081
988	TESTED.		3	7·124	1·3	·003	·007	–	–	–	–	–	·009	23,500	17,705
	Tensile, 27 March 1857.														
	Temp. 54°.														
989			1	7·148	1·3	·002	·005	·008	·010	–	–	–	·012	33,700	25,388
990	Transverse, 26 Jan. 1857.	Quick -	2	7·154	1·3	·003	·006	·009	·012	–	–	–	·013	32,000	24,108
991	Temp. 55°.		3	7·178	1·3	·002	·005	·008	·010	·012	–	–	·016	36,900	27,800
	Torsion, 22 April 1857.														
992	Temp. 58°.		1	7·121	1·3	·002	·004	–	–	–	–	–	·007	25,000	18,834
993		Slow -	2	7·104	1·3	·001	·003	–	–	–	–	–	·007	24,500	18,458
994	Crushing, 29 Jan. 1859.		3	7·135	1·3	·001	·003	·008	–	–	–	–	·012	26,200	19,739
	Temp. 55°.														
995			1	7·093	1·3	·001	·003	–	–	–	–	–	·008	23,000	17,328
996	FRACTURE.	Vertical. Gradual	2	7·120	1·3	·000	·002	–	–	–	–	–	·004	23,000	18,006
997	Medium Grey.		3	7·121	1·3	·002	·005	–	–	–	–	–	·008	23,100	17,403
	Dull.														
	Regular.														
998	Medium Grain.		1	7·100	1·3	·003	·005	·006	·010	–	–	–	·011	30,800	23,207
999	Good working qualities.	Quick -	2	7 160	1·3	·003	·005	·008	·010	–	–	–	·012	32,000	24,108
1,000			3	7·079	1·3	·002	·004	·006	·008	–	–	–	·009	30,500	22,978
	GENERAL MEAN - - -			7·125	1·3	·002	·005	·008	·010	–	–	–	·010	27,233	20,517

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
983	2·02	2·00	8·0800	·063	·006	·150	·023	–	–	·170	11,100	6,868	–	–	–	–	–	–	–	–	–	–	–	–	–
984	1·96	2·04	8·1567	·065	·008	·150	·027	–	–	·159	11,000	6,742	–	–	–	–	–	–	–	–	–	–	–	–	–
985	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·	·0	1·	–	–	–	–	–	–	–	–	5°·
986	1·97	2·01	7·9589	·070	·003	·175	·030	–	–	·195	10,700	6,721	–	–	–	–	–	–	–	–	–	–	–	–	–
987	1·98	1·93	7·3753	·078	·008	–	–	–	–	·195	9,700*	6,576*	–	–	–	–	–	–	–	–	–	–	–	–	–
988	–	–	–	–	–	–	–	–	–	–	–	–	1·8	6·	·0	6·	–	–	–	–	–	–	–	–	12°·
989	2·00	2·01	8·0802	·055	·007	·120	·020	–	–	·156	11,800	7,301	–	–	–	–	–	–	–	–	–	–	–	–	–
990	2·01	1·99	7·9598	·057	·001	·126	·010	–	–	·180	12,800	8,040	–	–	–	–	–	–	–	–	–	–	–	–	–
991	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·	·0	3·	8·5	3·5	5·	–	–	–	–	–	25°·
992	1·98	1·96	7·6063	·067	·008	·163	·028	–	–	·171	11,000	7,230	–	–	–	–	–	–	–	–	–	–	–	–	–
993	1·96	1·96	7·5295	·066	·005	–	–	–	–	·141	10,000	6,640	–	–	–	–	–	–	–	–	–	–	–	–	–
994	–	–	–	–	–	–	–	–	–	–	–	–	1·8	4·5	·0	4·5	–	–	–	–	–	–	–	–	19°·
995	1·96	1·96	7·5295	·071	·007	–	–	–	–	·170	10,000	6,640	–	–	–	–	–	–	–	–	–	–	–	–	–
996	1·96	1·97	7·6065	·070	·005	–	–	–	–	·150	10,000	6,573	–	–	–	–	–	–	–	–	–	–	–	–	–
997	–	–	–	–	–	–	–	–	–	–	–	–	1·799	6·	·0	6·	–	–	–	–	–	–	–	–	14°·5
998	1·99	1·99	7·8805	·055	·002	–	–	–	–	·137	9,900	6,281	–	–	–	–	–	–	–	–	–	–	–	–	–
999	1·96	1·96	7·2595	·063	·003	·131	·015	–	–	·151	11,800	7,835	–	–	–	–	–	–	–	–	–	–	–	–	–
1,000	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·	·0	3·	9·	4·	5·	–	–	–	–	–	11°·
	1·98	1·98	7·7623	·065	·005	·145	·022	–	–	·166	10,816*	6,954*	1·799	3·9	·0	3·9	8·7	3·7	5·	–	–	–	–	–	14°·4

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 22, at the end.

IRON WORKS, DUDLEY.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·07
Silicon	1·48
Sulphur	0·03
Phosphorus	0·43
Manganese	0·96

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·130	19,361	6,805	4,301	67,198	8·643	3·037	1·920	29·999
1,000	4,301	30°	1·20	1·3	·6	2·16	·030	·017	·013	-	-	-	-	-	-	-	-	-	-	-	-	19,000	67,198									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·118	17,955	6,648*	5,186	67,198	8·015	2·967*	2·315	29·999
1,210	5,186	40°	1·84	1·3	·6	2·16	·027	·010	·017	-	-	-	-	-	-	-	-	-	-	-	-	19,000	67,198									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·160	25,765	7,670	8,230	94,431	11·502	3·424	3·674	42·156
1,920	8,230	40°	2·42	1·3	·6	2·16	·025	·013	·012	·055	·033	·022	·107	·075	·032	-	-	-	-	-	-	26,700	94,431									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·120	19,010	6,935	6,387	68,613	8·486	3·095	2·851	30·630
1,490	6,387	33°	1·88	1·3	·6	2·16	·030	·017	0·13	-	-	-	-	-	-	-	-	-	-	-	-	19,400	68,613									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·111	17,579	6,606	6,011	63,661	7·847	2·949	2·683	28·420
1,400	6,011	40°	1·76	1·3	·6	2·16	·050	·037	·013	-	-	-	-	-	-	-	-	-	-	-	-	18,000	63,661									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·113	23,431	7,058	6,666	82,760	10·460	3·150	2·975	36·946
1,550	6,666	36°	2·05	1·3	·6	2·16	·025	·010	·015	·056	·031	·025	-	-	-	-	-	-	-	-	-	23,400	82,760									
1,428	6,130	36°	1·86	1·3	·6	2·16	·031	·017	·014	·056	·032	·024	·107	·075	·032	-	-	-	-	-	-	20,916	73,977	7·125	20,517	6,954*	6,130	73,977	9·159	3·104*	2·736	33·022
																								7·136	21,027	7,041*	5,905	76,276	9·387	3·143*	2·636	34·051
																								7·114	20,006	6,866	6,354	71,678	8·928	3·065	2·836	31·999
																								7·125	19,185	6,870	5,344	67,906	8·564	3·066	2·385	30·315
																								7·115	17,767	6,627*	5,598	65,430	7·931	2·958*	2·498	29·209
																								7·137	24,598	7,364	7,448	88,596	10·981	3·287	3·325	39·551
																													·277	·094	·082	1·000

Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - - -

Vertical - - - -

Horizontally and Vertically cast - - - Slow - - - - -

Gradual - - - -

Quick - - - -

Ratio in terms of the Crushing Force - - -

497·

MESSRS. GRAZEBROOK, NETHERTON

No. 2.—

MANUFACTURE.

First running from the cold-blast furnace, smelted with coke made from the best coal for smelting iron.

The whole of the ironstone and coke obtained from the mines of Messrs. Grazebrook, adjacent to the works.

Cast	16 September 1856.
Barometer	30·16
Thermometer	62·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	18
Runners	0	2	0
Slag and waste	0	2	20
Coals consumed	4	0	13

Time of—	hrs.	min.
Melting	0	35
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight Observed.	Reduced to per Square Inch.
1001			1	7·164	1·3	·001	·004	·008	·011	–	–	–	·012	34,000	23,615
1002	Mark $\frac{2}{2}$.	Slow	2	7·183	1·3	·002	·005	·008	·010	–	–	–	·012	34,500	23,992
1003			3	7·188	1·3	·002	·004	·006	·008	–	–	–	·011	34,000	20,293
	CAST.														
1004	16 September 1856.		1	7·168	1·3	·001	·003	·005	·008	–	–	–	·010	34,000	26,293
1005		Horizontal. Gradual	2	7·175	1·3	000	·002	·004	·006	–	–	–	·009	34,000	25,615
1006	TESTED.		3	7·178	1·3	·002	·004	·006	·008	–	–	–	·011	34,200	25,766
	Tensile, 27 March 1857.														
1007	Temp. 56°.		1	7·168	1·3	·002	·004	·006	·008	–	–	–	·010	33,900	25,539
1008	Transverse, 28 Jan. 1857.	Quick	2	7·176	1·3	·000	·002	·004	·006	–	–	–	·009	34,700	26,142
1009	Temp. 57°.		3	7·164	1·3	·002	·004	·006	·008	–	–	–	·009	34,800	26,218
	Torsion, 22 April 1857.														
1010	Temp. 58°.		1	7·166	1·3	·000	·003	·006	·010	–	–	–	·012	33,000	24,861
1011		Slow	2	7·180	1·3	·003	·006	·008	·010	–	–	–	·013	33,000	24,861
1012	Crushing, 29 Jan. 1859.		3	7·159	1·3	·001	·004	·008	·010	–	–	–	·011	33,200	25,012
	Temp. 55°.														
1013	FRACTURE.	Vertical.	1	7·175	1·3	·002	·004	·006	·008	–	–	–	·010	34,800	26,218
1014	Medium Grey.	Gradual	2	7·162	1·3	·002	·004	·006	·008	–	–	–	·011	34,900	26,293
1015	Dull. Regular.		3	7·186	1·3	·003	·006	·009	·011	–	–	–	·013	34,900	26,293
	Medium Grain.														
1016			1	7·188	1·3	·002	·005	·007	·009	·012	–	–	·014	36,300	27,346
1017	Good working qualities.	Quick	2	7·190	1·3	·002	·004	·006	·007	·008	–	–	·012	36,500	27,499
1018			3	7·196	1·3	·003	·006	·008	·010	·011	–	–	·011	35,000	26,368
	GENERAL MEAN			7·175	1·3	·002	·004	·006	·009	·010	–	–	·011	34,528	26,012

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,600 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1001	2·02	2·00	8·0800	·059	·000	·129	·018	–	–	·227	14,700	9,096	–	–	–	–	–	–	–	–	–	–	–	–	–
1002	2·03	1·96	7·7984	·063	·000	·139	·020	–	–	·221	13,800	8,847	–	–	–	–	–	–	–	–	–	–	–	–	–
1003	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·5	·0	3·5	8·5	5·	3·5	–	–	–	–	–	–	20°·
1004	1·99	2·05	8·3624	·058	·000	·128	·011	–	–	·212	14,200	8,489	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1005	1·99	1·96	7·6447	·060	·002	·140	·020	–	–	·238	14,100	9,221	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1006	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·0	·0	3·0	8·5	4·	4·5	–	–	–	–	–	–	14°·
1007	2·02	2·00	8·0800	·063	·002	·135	·020	–	–	·218	14,000	8,663	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1008	2·01	2·04	8·3648	·056	·000	·126	·020	–	–	·220	14,800	8,846	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1009	–	–	–	–	–	–	–	–	–	–	–	–	1·796	3·0	·0	3·0	–	–	–	–	–	–	–	–	–	8°·
1010	1·98	1·99	7·8409	·065	·008	–	–	–	–	·145	10,000	6,376	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1011	1·97	1·98	7·7231	·060	·000	·130	·016	–	–	·164	11,500	7,445	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1012	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·5	·0	3·5	9·	5·	4·	–	–	–	–	–	–	12°·
1013	1·96	1·95	7·4529	·068	·008	·145	·025	–	–	·170	11,300	7,580	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1014	1·96	1·97	7·6065	·062	·008	·138	·020	–	–	·176	11,700	7,690	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1015	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·5	·0	3·5	9·	4·7	4·3	–	–	–	–	–	–	18°·5
1016	1·97	1·97	7·6453	·060	·005	·130	·019	–	–	·172	11,300	7,390	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1017	1·97	1·94	7·4142	·060	·005	·130	·019	–	–	·200	11,900	8,025	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1018	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·5	·0	3·5	9·	4·5	4·5	–	–	–	–	–	–	17·°
	1·99	1·98	7·8015	·061	·003	·134	·019	–	–	·196	12,775	8,139	1·799	3·3	·0	3·3	8·8	4·6	4·2	–	–	–	–	–	–	14°·9

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 23, at the end.

IRON WORKS, NEAR DUDLEY.

MELTING PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·04
Silicon	1·27
Sulphur	0·04
Phosphorus	0·34
Manganese	0·80

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·178	25,966	8,972	7,758	87,358	11·591	4·005	3·463	38·095
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,810	7,758	33°	1·94	1·3	·6	2·16	·023	·010	·013	·050	·030	·020	-	-	-	-	-	-	-	-	24,700	87,358									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·173	25,891	8,855	6,858	86,650	11·558	3·953	3·061	38·683
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,600	6,858	42°	2·07	1·3	·6	2·16	·030	·013	·017	·055	·018	·037	-	-	-	-	-	-	-	-	24,500	86,650									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·169	25,966	8,754	6,429	87,004	11·591	3·908	2·870	38·839
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,490	6,429	41°	1·33	1·3	·6	2·16	·032	·017	·015	·059	·037	·022	-	-	-	-	-	-	-	-	24,600	87,004									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·168	24,911	6,910	6,472	84,882	11·120	3·084	2·889	37·80
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,510	6,472	34°	1·97	1·3	·6	2·16	·024	·010	·014	·050	·029	·021	-	-	-	-	-	-	-	-	24,000	84,882									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·174	26,268	7,635	7,887	86,297	11·726	3·408	3·520	38·52
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,840	7,887	37°	2·18	1·3	·6	2·16	·020	·008	·012	·050	·030	·020	-	-	-	-	-	-	-	-	24,400	86,297									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·191	27,071	7,707	7,716	86,650	12·085	3·440	3·444	38·68
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,800	7,716	35°	2·21	1·3	·6	2·16	·024	·010	·014	·049	·027	·022	-	-	-	-	-	-	-	-	24,500	86,650									
1,675	7,186	37°	1·95	1·3	·6	2·16	·025	·011	·014	·052	·028	·024	-	-	-	-	-	-	-	-	24,450	86,473	7·175	26,012	8,139	7,186	86,473	11·612	3·633	3·208	38·66
Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - -																							7·173	25,941	8,860	7,015	87,004	11·580	3·955	3·131	38·83
Vertical - - - -																							7·178	26,083	7,417	7,358	85,943	11·644	3·311	3·284	38·30
Horizontally and Vertically cast - - - Slow - - - - -																							7·173	25,438	7,941	7,115	86,120	11·356	3·544	3·176	38·44
Gradual - - - -																							7·173	26,079	8,245	7,372	86,474	11·642	3·680	3·291	38·66
Quick - - - - -																							7·180	26,518	8,230	7,072	86,827	11·838	3·674	3·157	38·74
Ratio in terms of the Crushing Force - - -																												·300	·094	·083	1·0

MESSRS. GRAZEBROOK, NETHERTON

GREY

MANUFACTURE.

First running from the cold-blast furnace, smelted with coke made from the best coal for smelting iron.

The whole of the ironstone and coke obtained from the mines of Messrs. Grazebrook, adjacent to the works.

CASTING.

Cast	17 September 1856.
Barometer	29·97
Thermometer	61°

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	18
Runners	0	2	7
Slag and waste	0	3	0
Coals consumed	3	3	9

Time of—	hrs.	min.
Melting	0	35
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.		No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1019	Mark $\frac{2}{3}$.			1	7·159	1·3	·002	·005	·009	·010	–	–	–	·012	32,000	24,108
1020			Slow -	2	7·175	1·3	·002	·004	·005	·008	–	–	–	·009	32,700	24,635
1021	CAST.			3	7·175	1·3	·003	·006	·009	·011	–	–	–	·012	31,900	24,033
1022	17 September 1856.			1	7·165	1·3	·002	·006	·008	·009	–	–	–	·011	33,100	24,936
1023		Horizontal.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1024	TESTED. Tensile, 28 March 1857.			3	7·153	1·3	·003	·006	·010	·012	–	–	–	·013	33,800	25,464
1025	Temp. 57°.			1	7·152	1·297	·002	·003	·006	·010	–	–	–	·012	32,800	24,768
1026	Transverse, 29 Jan. 1857. Temp. 50°.		Quick -	2	7·162	1·3	·002	·005	·006	·009	–	–	–	·011	33,000	24,861
1027	Torsion, 23 April 1857.			3	7·185	1·3	·001	·003	·006	·008	–	–	–	·009	32,300	24,334
1028	Temp. 58°.			1	7·176	1·3	·002	·006	·007	·010	–	–	–	·011	31,800	23,958
1029	Crushing, 29 Jan. 1859.		Slow -	2	7·140	1·3	·004	·007	·010	–	–	–	–	·013	29,500	22,225
1030	Temp. 55°.			3	7·159	1·3	·003	·008	·011	–	–	–	–	·014	29,500	22,225
1031	FRACTURE.			1	7·140	1·3	·003	·006	·008	·011	–	–	–	·013	31,800	23,958
1032	Light Grey in centre. Dull in the margin.	Vertical.	Gradual	2	7·155	1·3	·002	·006	·010	·012	–	–	–	·012	30,500	22,978
1033	Regular. Medium Grain.			3	7·171	1·3	·002	·005	·008	·011	–	–	–	·012	31,900	24,033
1034	Good working qualities.			1	7·152	1·3	·001	·004	·007	·009	–	–	–	·010	33,300	25,087
1035			Quick -	2	7·155	1·3	·002	·004	·006	·008	–	–	–	·011	33,900	25,539
1036				3	7·170	1·3	·001	·004	·008	·010	–	–	–	·012	32,700	24,635
	GENERAL MEAN - - -				7·161	1·3	·002	·005	·008	·009	–	–	–	·012	32,147	24,222

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1019	2·03	1·96	7·7984	·060	·000	·145	·020	–	–	·200	13,000	8,334	–	–	–	–	–	–	–	–	–	–	–	–	–
1020	2·02	2·00	8·0800	·060	·000	·130	·018	–	–	·180	12,400	7,673	–	–	–	–	–	–	–	–	–	–	–	–	–
1021	–	–	–	–	–	–	–	–	–	–	–	–	1·8	4·	1·	3·	12·	7·	5·	–	–	–	–	–	–	12°·5
1022	2·00	2·06	8·4872	·050	·000	·120	·012	–	–	·168	12,400	7,305	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1023	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1024	–	–	–	–	–	–	–	–	–	–	–	–	1·8	4·2	1·5	2·7	12·	7·5	4·5	–	–	–	–	–	–	12°·5
1025	2·01	1·99	7·9598	·060	·005	·130	·019	–	–	·178	12,300	7,726	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1026	2·04	1·97	7·9170	·057	·007	·137	·012	–	–	·200	13,100	8,273	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1027	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·5	·5	3·	–	–	–	–	–	–	–	–	–	7°·5
1028	1·98	1·97	7·6831	·068	·012	·144	·026	–	–	·174	11,800	7,678	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1029	1·98	2·01	7·9993	·065	·010	·140	·026	–	–	·160	11,000	6,875	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1030	–	–	–	–	–	–	–	–	–	–	–	–	1·8	4·5	1·	3·5	–	–	–	–	–	–	–	–	–	15°·
1031	1·97	1·98	7·7231	·060	·006	·138	·020	–	–	·171	11,300	7,315	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1032	1·98	1·99	7·8409	·056	·005	·130	·019	–	–	·174	12,300	7,843	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1033	–	–	–	–	–	–	–	–	–	–	–	–	1·8	4·	1·	3·	12·5	7·5	5·	–	–	–	–	–	–	13°·5
1034	2·01	2·03	8·2830	·058	·006	·130	·020	–	–	·169	11,500	6,941	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1035	2·00	1·99	7·9202	·058	·004	·130	·018	–	–	·181	12,700	8,017	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1036	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·	·0	3·	9·5	5·	4·5	–	–	–	–	–	–	16°·
	2·00	2·00	8·0000	·059	·005	·134	·019	–	–	·177	12,163	7,634	1·8	3·8	·8	3·	11·5	6·7	4·8	–	–	–	–	–	–	14°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 24, at the end.

IRON WORKS, NEAR DUDLEY.

FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·12
Silicon	1·16
Sulphur	0·05
Phosphorus	0·44
Manganese	0·94

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,500	6,430	41°	1·98	1·3	·6	2·16	·026	·011	·015	·059	·038	·021	-	-	-	-	-	-	-	-	-	23,000	81,345	7·169	24,258	8,003	6,430	81,345	10·824	3·572	2·870	36·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,500	6,430	38°	1·90	1·3	·6	2·16	·025	·010	·015	·054	·032	·022	-	-	-	-	-	-	-	-	-	24,000	84,882	7·159	25,200	7,305	6,430	84,882	11·250	3·261	2·870	37·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,010	4,351	35°	0·90	1·3	·6	2·16	·026	·011	·015	·055	·030	·025	-	-	-	-	-	-	-	-	-	23,800	84,175	7·166	24,654	7,999	4,351	84,175	11·006	3·570	1·942	37·578
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,480	6,344	40°	1·76	1·3	·6	2·16	·027	·012	·015	·060	·039	·021	-	-	-	-	-	-	-	-	-	22,200	78,516	7·158	22,802	7,276	6,344	78,516	10·179	3·248	2·832	35·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,510	6,472	40°	2·09	1·3	·6	2·16	·026	·010	·016	·059	·020	·039	-	-	-	-	-	-	-	-	-	22,800	80,638	7·155	23,656	7,579	6,472	80,638	10·560	3·383	2·889	35·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,080	7,201	36°	1·70	1·3	·6	2·16	·025	·010	·015	·054	·030	·024	-	-	-	-	-	-	-	-	-	24,000	84,882	7·159	25,087	7,479	7,201	84,882	11·199	3·338	3·214	37·893
1,446	6,204	38°	1·72	1·3	·6	2·16	·026	·011	·015	·057	·031	·026	-	-	-	-	-	-	-	-	-	23,300	82,406	7·161	24,222	7,634	6,204	82,406	10·813	3·408	2·769	36·788
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·165	24,642	7,862	5,737	82,434	11·000	3·509	2·561	36·800
Vertical - - - -																								7·157	23,848	7,444	6,672	81,345	10·646	3·323	2·978	36·314
Horizontally and Vertically cast - - - Slow - - - - -																								7·164	23,530	7,639	6,387	79,931	10·504	3·410	2·851	35·683
Gradual - - - -																								7·157	24,428	7,442	6,451	82,760	10·905	3·322	2·879	36·946
Quick - - - - -																								7·163	24,870	7,739	5,776	83,029	11·102	3·454	2·578	37·066
																													Ratio in terms of the Crushing Force - - -				·293	·092	·075	1·000

MESSRS. GRAZEBROOK, NETHERTON

No. 4 and 5.—

MANUFACTURE.

First running from the cold-blast furnace, smelted with coke made from the best coal for smelting iron.

The whole of the ironstone and coke obtained from the mines of Messrs. Grazebrook, adjacent to the works.

Cast - - - 17 September 1856.
Barometer - - - 29·97
Thermometer - - 61°

CASTING.

Weight of—	cwts.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	4	0	22
Runners - -	0	1	25
Slag and waste -	0	2	18
Coals consumed -	3	0	15

Time of—	hrs.	min.
Melting - - -	0	33
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1037			1	7·227	1·3	·002	·005	·008	·010	·014	–	–	·017	39,900	30,060
1038	Mark $\frac{2}{4}$.	Slow -	2	7·234	1·3	·002	·006	·010	·012	·013	–	–	·013	39,000	29,382
1039			3	7·235	1·3	·003	·005	·007	·008	·010	·011	–	·012	41,000	30,889
1040	CAST. 17 September 1856.		1	7·234	1·3	·006	·008	·010	·012	·014	–	–	·015	38,000	28,628
1041	TESTED.	Horizontal. Gradual	2	7.212	1·3	·001	·004	·007	·010	·012	·013	–	·017	42,000	31,642
1042	Tensile, 31 March 1857. Temp. 55°.		3	7·226	1·3	·001	·003	·006	·008	·009	·010	–	·012	40,900	30,813
1043			1	7·239	1·3	·003	·006	·009	·011	·014	–	–	·015	39,800	29,985
1044	Transverse, 29 Jan. 1857. Temp. 50°.	Quick -	2	7·238	1·3	·002	·005	·008	·010	·012	·013	–	·017	40,900	30,813
1045			3	7·220	1·3	·002	·005	·006	·008	·010	·011	·012	·012	45,100	33,977
1046	Torsion, 23 April 1857. Temp. 58°.		1	7·233	1·3	·002	·004	·008	·010	·012	–	–	·015	39,500	29,759
1047	Crushing, 28 Jan. 1859.	Slow -	2	7·244	1·3	·003	·005	·007	·009	·011	–	–	·013	38,000	28,628
1048	Temp. 56°.		3	7·223	1·3	·002	·005	·008	·010	·011	–	–	·012	37,000	27,875
1049	FRACTURE. Light Grey.		1	7·228	1·3	·002	·005	·007	·008	·010	·012	–	·015	41,000	30,889
1050	Bright.	Vertical. Gradual	2	7·217	1·3	·003	·006	·008	·011	·013	·015	–	·015	40,000	30,135
1051	Regular.		3	7·235	1·3	·003	·005	·007	·009	·010	–	–	·012	39,000	29,382
1052	Fine Grain. Good working qualities.		1	7·174	1·3	·003	·006	·009	·010	·011	·012	–	·014	42,100	31,717
1053		Quick -	2	7·111	1·3	·002	·005	·006	·008	·010	·012	–	·012	40,000	30,135
1054			3	7·192	1·3	·003	·006	·009	·011	·012	·013	–	·014	41,800	31,492
	GENERAL MEAN - - -			7·217	1·3	·002	·005	·008	·010	·012	·012	·012	·014	40,277	30,344

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1037	2·02	1·98	7·9192	·050	·004	·068	·015	·211	·050	·212	15,100	9,511
1038	1·99	2·08	8·6095	·050	·001	·103	·010	·183	·036	·227	17,000	9,872
1039	–	–	–	–	–	–	–	–	–	–	–	–
1040	2·00	2·00	8·0000	·050	·002	·100	·010	·191	·040	·226	16,500	10,312
1041	2·01	1·97	7·8006	·052	·002	·112	·013	–	–	·208	15,000	9,614
1042	–	–	–	–	–	–	–	–	–	–	–	–
1043	2·03	1·99	8·0399	·053	·003	·111	·012	·182	·030	·221	17,000	10,573
1044	2·04	2·00	8·1600	·050	·000	·105	·009	–	–	·170	15,000	9,191
1045	–	–	–	–	–	–	–	–	–	–	–	–
1046	2·01	2·03	8·2830	·050	·004	·104	·009	–	–	·186	15,000	9,054
1047	2·01	2·02	8·2016	·049	·001	·110	·010	·193	·040	·230	16,500	10,059
1048	–	–	–	–	–	–	–	–	–	–	–	–
1049	1·99	2·01	8·0397	·050	·003	·101	·010	–	–	·195	15,000	9,328
1050	1·98	1·99	7·8409	·049	·001	·110	·009	–	–	·195	15,000	9,565
1051	–	–	–	–	–	–	–	–	–	–	–	–
1052	1·99	1·99	7·8805	·050	·002	·110	·010	–	–	·156	14,000	8,882
1053	2·00	1·99	7·9202	·049	·000	·105	·006	–	–	·176	15,000	9,469
1054	–	–	–	–	–	–	–	–	–	–	–	–
	2·01	2·00	8·0400	·050	·002	·103	·010	·192	·039	·200	15,508	9,619

Register No.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1037	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1038	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1039	1·8	3·5	1°	2·5	10°	6°	4°	–	–	–	–	–	–	14°
1040	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1041	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1042	1·8	2·5	·5	2°	8°	4·5	3·5	21°	15°	6°	–	–	–	26°
1043	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1044	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1045	1·8	2°	·0	2°	–	–	–	–	–	–	–	–	–	5°·5
1046	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1047	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1048	1·8	3·5	1°	2·5	9°	5°	4°	–	–	–	–	–	–	10°·5
1049	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1050	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1051	1·8	2·5	·5	2°	6·5	3·5	3°	17·5	11°	6·5	–	–	–	20°·5
1052	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1053	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1054	1·798	3°	·0	3°	6·5	2°	4·5	–	–	–	–	–	–	8°·5
	1·8	2·8	·5	2·3	8°	4·2	3·8	19·2	13°	6·2	–	–	–	14°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 25, at the end.

IRON WORKS, NEAR DUDLEY.

FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·03
Silicon	0·83
Sulphur	0·04
Phosphorus	0·31
Manganese	0·27

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·232	30,110	9,691	6,687	103,627	13·441	4·326	2·985	46·262
1,560	6,687	37°	1·96	1·3	·6	2·16	·021	·009	·012	·043	·021	·022	·076	·048	·028	–	–	–	–	–	–	29,300	103,627									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·224	30,361	9,963	8,873	105,749	13·554	4·447	3·961	47·254
2,070	8,873	39°	2·26	1·3	·6	2·16	·010	·000	·010	·031	·013	·018	·059	·035	·024	–	–	–	–	–	–	29,900	105,749									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·232	31,591	9,882	6,001*	119,188	14·103	4·401	2·679*	53·360
1,400*	6,001*	35°	1·63	1·3	·6	2·16	·017	·004	·013	·036	·013	·023	·055	·026	·029	·090	·054	·036	–	–	–	33,700	119,188									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·233	28,754	9,556	6,515	99,736	12·836	4·266	2·908	44·525
1,520	6,515	36°	1·89	1·3	·6	2·16	·020	·009	·011	·043	·020	·023	·073	·045	·028	–	–	–	–	–	–	28,200	99,736									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·226	30,135	9,446	8,830	102,566	13·453	4·216	3·941	45·788
2,060	8,830	37°	2·14	1·3	·6	2·16	·021	·005	·016	·040	·021	·019	·069	·042	·027	–	–	–	–	–	–	29,000	102,566									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·159	31,114	9,175	8,516	118,835	13·890	4·095	3·801	53·051
1,980	8,516	40°	2·04	1·3	·6	2·16	·016	·003	·013	·035	·012	·023	·054	·026	·028	·085	·051	·034	–	–	–	33,600	118,835									
1,765*	7,570*	37°	1·98	1·3	·6	2·16	·017	·005	·012	·038	·017	·021	·064	·037	·027	·088	·053	·035	–	–	–	30,617	108,285	7·217	30,344	9,619	7,570*	108,285	13·546	4·294	3·379*	48·341
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·229	30,687	9,845	7,187*	109,521	13·699	4·395	3·208*	48·893
Vertical - - - -																								7·206	30,001	9,392	7,953	107,046	13·393	4·192	3·550	47·788
Horizontally and Vertically cast - - - Slow - - - - -																								7·233	29,432	9,623	6,601	101,682	13·139	4·295	2·679	45·392
Gradual - - - -																								7·225	30,248	9,704	8,851	104,158	13·503	4·332	3·951	46·499
Quick - - - -																								7·196	31,352	9,528	7,258*	119,012	13·996	4·253	3·240*	53·129
																													·279	·088	·069	1·000

Ratio in Terms of the Crushing Force - - -

MESSRS. GRAZEBROOK, NETHERTON

No. 5.—

MANUFACTURE.

First running from the cold-blast furnace, smelted with coke made from the best coal for smelting iron.

The whole of the ironstone and coke obtained from the mines of Messrs. Grazebrook, adjacent to the works.

Cast	17 September 1856.
Barometer	29·27
Thermometer	61·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	18
Runners	0	1	20
Slag and waste	0	3	23
Coals consumed	3	2	8

Time of—	hrs.	min.
Melting	0	35
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1055			1	-	-	-	-	-	-	-	-	-	-	-	-
1056	Mark $\frac{2}{5}$.	Slow	2	-	-	-	-	-	-	-	-	-	-	-	-
1057			3	-	-	-	-	-	-	-	-	-	-	-	-
1058	CAST. 17 September 1856.	Horizontal. Gradual	1	-	-	-	-	-	-	-	-	-	-	-	-
1059			2	-	-	-	-	-	-	-	-	-	-	-	-
1060	TESTED.		3	-	-	-	-	-	-	-	-	-	-	-	-
1061	Transverse, 30 Jan. 1857. Temp. 53°.		1	-	-	-	-	-	-	-	-	-	-	-	-
1062		Quick	2	-	-	-	-	-	-	-	-	-	-	-	-
1063	FRACTURE. Slow.—Inclined to be silvery.		3	-	-	-	-	-	-	-	-	-	-	-	-
1064			1	-	-	-	-	-	-	-	-	-	-	-	-
1065	Gradual.—Mottled; inclined to be silvery.	Slow	2	-	-	-	-	-	-	-	-	-	-	-	-
1066	Quick.—Silvery.		3	-	-	-	-	-	-	-	-	-	-	-	-
1067	The vertical bars are whiter than the horizontal.	Vertical.	1	-	-	-	-	-	-	-	-	-	-	-	-
1068		Gradual	2	-	-	-	-	-	-	-	-	-	-	-	-
1069	The metal of this sample being too hard to turn into cylinders, could only be tested by transverse strain.		3	-	-	-	-	-	-	-	-	-	-	-	-
1070			1	-	-	-	-	-	-	-	-	-	-	-	-
1071		Quick	2	-	-	-	-	-	-	-	-	-	-	-	-
1072			3	-	-	-	-	-	-	-	-	-	-	-	-
	GENERAL MEAN			-	-	-	-	-	-	-	-	-	-	-	-

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1055	2·00	1·97	7·7618	·050	·002	·110	·010	·169	·028	·180	15,900	10,242	-	-	-	-	-	-	-	-	-	-	-	-	-
1056	1·98	1·98	7·7623	·050	·005	·100	·010	·168	·027	·180	15,800	10,177	-	-	-	-	-	-	-	-	-	-	-	-	-
1057	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1058	2·01	1·98	7·8800	·049	·005	·096	·008	-	-	·141	15,000	9,517	-	-	-	-	-	-	-	-	-	-	-	-	-
1059	1·96	2·01	7·9185	·045	·003	·091	·007	-	-	·138	14,500	9,155	-	-	-	-	-	-	-	-	-	-	-	-	-
1060	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1061	1·98	1·96	7·6063	·040	·000	·084	·002	-	-	·100	12,000	7,888	-	-	-	-	-	-	-	-	-	-	-	-	-
1062	1·96	1·98	7·6839	·050	·010	·089	·018	-	-	·108	11,000	7,157	-	-	-	-	-	-	-	-	-	-	-	-	-
1063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1064	2·01	2·01	8·1206	·045	·005	·090	·008	-	-	·135	14,900*	9,174*	-	-	-	-	-	-	-	-	-	-	-	-	-
1065	2·03	2·01	8·2014	·050	·004	·100	·007	-	-	·138	13,700*	8,352*	-	-	-	-	-	-	-	-	-	-	-	-	-
1066	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1067	1·96	1·96	7·5295	·045	·003	·092	·006	-	-	·105	11,000*	7,304*	-	-	-	-	-	-	-	-	-	-	-	-	-
1068	1·98	1·99	7·8409	·043	·003	·088	·006	-	-	·121	13,900*	8,863*	-	-	-	-	-	-	-	-	-	-	-	-	-
1069	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1070	1·98	1·97	7·6831	-	-	-	-	-	-	·046	5,000*	3,253*	-	-	-	-	-	-	-	-	-	-	-	-	-
1071	1·97	1·98	7·7231	·045	·002	-	-	-	-	·087	10,000*	6,474*	-	-	-	-	-	-	-	-	-	-	-	-	-
1072	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1·99	1·98	7·8015	·047	·004	·094	·008	·168	·027	·123	12,725*	8,129*	-	-	-	-	-	-	-	-	-	-	-	-	-

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 26, at the end.

IRON WORKS, NEAR DUDLEY.

STRONG FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·81
Silicon	0·57
Sulphur	0·06
Phosphorus	0·29
Manganese	0·13

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	10,209	- -	- -	- -	4·557	—	—
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	9,336	- -	- -	- -	4·167	—	—
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7,522	- -	- -	- -	3·358	—	—
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	8,763*	- -	- -	- -	3·912*	—	—
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	8,083*	- -	- -	- -	3·608*	—	—
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	4,863*	- -	- -	- -	2·170*	—	—
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	8,129*	- -	- -	- -	3·629*	—	—
Combined Means - - - { Slow, Gradual and Quick cooling - - - { Horizontal - - -																										9,022	- -	- -	- -	4·030	—	—
																										7,236*	- -	- -	- -	3·230*	—	—
Vertical - - - -																																	
Horizontally and Vertically cast - - - { Slow - - - - -																										9,486*	- -	- -	- -	4·234*	—	—
Gradual - - - -																										8,709*	- -	- -	- -	3·887*	—	—
Quick - - - -																										6,192*	- -	- -	- -	2·764*	—	—
Ratio in terms of the Crushing Force - - -																																	

NETHERTON IRON WORKS, NEAR DUDLEY.

(Messrs. M. & W. Grazebrook.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores.

I. "*Binds.*"—Light brownish-grey clay ironstone, intersected by a few very thin veins of limespar. The specimens measured two inches in depth.

II. "*Whitestone.*"—Pale brownish-grey clay ironstone; homogeneous.

III. "*Whitestone.*"—A brownish-grey clay ironstone, containing fossil shells, which are disposed generally in the direction of the plane of stratification.

IV. "*Gubbin.*"—An average was prepared for analysis from the two samples of clay ironstone received under this name. The one, measuring five inches in depth, was blackish-grey in colour; homogeneous, and had a distinctly crystalline structure. The other, similar in colour, but with a structure not so decidedly crystalline. The latter contained a few seams of limespar.

V. "*Grains.*"—A blackish-grey clay ironstone, intersected by numerous yellowish veins of limespar.

VI. "*Grains.*"—Clay ironstone, similar in colour to the last, but homogeneous in character.

	I. Binds.	II. Whitestone.	III. Whitestone.	IV. Gubbin.	V. Grains.	VI. Grains.
Protoxide of iron	44·74	51·52	47·70	49·28	50·40	48·43
Protoxide of manganese	0·50	0·56	0·84	1·24	0·75	0·84
Lime	1·70	1·28	2·85	1·29	1·70	1·00
Magnesia	2·05	1·66	2·45	0·92	1·19	1·32
Carbonic acid	30·63	33·17	34·36	32·83	33·70	32·53
Phosphoric acid	0·72	0·60	0·56	0·66	0·45	0·59
Water, hygroscopic	0·34	0·25	0·32	0·26	0·30	0·34
Water, in combination	1·51	1·20	1·23	1·59	1·41	1·61
Organic matter	*trace*	*trace*	0·25	0·68	0·50	0·52
Clay, ignited	18·17	10·07	9·87	11·09	9·70	12·41
	100·36	100·31	100·43	99·84	100·10	99·59
Metallic iron	35·25	40·32	37·35	38·60	39·45	37·97

Neither of these ores contain any more than a trace of sulphur, in the form of bisulphide of iron.

NETHERTON IRON WORKS, NEAR DUDLEY—*continued.*

FUEL.

The *"Thick Coal"* employed at the Netherton Works in the production of their coke, contains—

Carbon	73·02 per cent.
Hydrogen	5·55 „
Sulphur	0·33 „
Ash	1·92 „

Heated in a close crucible it yielded—

Coke	54·08 per cent.

The *Thick Coal-Coke* contained—

Sulphur	0 31 per cent.

and left, on burning,

Ash	4·18 per cent.

The ash, consisting of reddish (burnt) shale, contained *silicate of alumina,* with *peroxide of iron, lime,* and a trace of *magnesia.*

FLUX.

Limestone from the Dudley Lime Quarries.—Two samples were received, from which an average was taken for analysis; both were light coloured and crystalline, one being coarser grained than the other.

(Sample dried at 212° Fahrenheit.)

Carbonate of lime	97·31
Carbonate of magnesia	1·00
Carbonate of iron	0·62
Clay and sand	1·27
Organic matter and water	0·20
	100·40

IRONS.

Important Constituents in 100 *Parts.*

Cold blast Irons.

	I. No. 1. Foundry Pig.	II. No. 2. Foundry Pig.	III. Grey Forge.	IV. Forge.	V. Strong Forge.
Carbon, as graphite	3·07	3·04	3·12	3·03	2·81
Silicon	1·48	1·27	1·16	0·83	0·57
Sulphur	0·03	0·04	0·05	0·04	0·06
Phosphorus	0·43	0·34	0·44	0·31	0·29
Manganese	0·96	0·80	0·94	0·27	0·13

Remarks.—Analyses of other samples of iron, representing supplies from these works, are given in the Appendix.

MESSRS. EVERS AND MARTIN,

FOUNDRY MELTING

MANUFACTURE.

Foundry pig iron manufactured from clay ironstone, coke, and limestone, smelted by cold blast, and of the first melting. The pigs are made from the following materials; viz.—

- Bottom stone and binds, from whitestone strata
- Gubbin and rubble, from gubbin strata
- Thick or 10-yard coal cokes
- Heathen coal cokes

The limestone is the produce of the Dudley quarries.

Cast — 2 October 1856.
Barometer — 29·80
Thermometer — 67·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	3	3	17
Runners	0	2	16
Slag and Waste	0	3	20
Coals consumed	4	0	1

Time of—	hrs.	min.
Melting	0	55
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1450	Mark $\frac{10}{1}$.A CAST. 2 October 1856. TESTED. Tensile, 3 Oct. 1857. Temp. 64°. Transverse, 4 Aug. 1857. Temp. 75°. Torsion, 14 Aug. 1857. Temp. 67°. Crushing, 29 Jan. 1859. Temp. 55°. FRACTURE. Light Grey Bluish. Regular. Fine Grain. Very good working.	Horizontal. Slow	1	7·208	1·3	·001	·004	·006	·007	–	–	–	·008	34,000	25,615	2·01	1·97	7·8006	·056	·005	·124	·015	–	–	·195	13,500	8,653	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1451			2	7·200	1·3	·001	·004	·006	·007	·012	–	–	·012	35,000	26,368	2·00	2·00	8·0000	·052	·000	·115	·010	–	–	·195	14,000	8,750	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1452			3	7·178	1·3	·001	·004	·005	·007	·011	–	–	·012	37,000	27,875	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·3	·1	2·2	7·8	4·	3·8	–	–	–	–	–	–	18°·8
1453		Horizontal. Gradual	1	7·205	1·3	·001	·004	·006	·007	·010	–	–	·012	36,800	27,725	2·01	2·01	8·1206	·055	·003	·120	·014	–	–	·177	13,000	8,004	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1454			2	7·202	1·3	·002	·005	·007	·008	·011	–	–	·013	37,300	28,101	1·97	1·99	7·8013	·056	·004	·119	·015	–	–	·167	12,500	8,011	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1455			3	7·211	1·3	·000	·003	·005	·007	·008	–	–	·009	36,500	27,498	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·1	·0	2·1	9·	5·	4·	–	–	–	–	–	–	19°·7
1456		Quick	1	7·217	1·3	·001	·004	·005	·007	·010	–	–	·014	39,000	29,382	1·98	2·02	8·0791	·050	·001	·110	·010	–	–	·171	13,500	8,354	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1457			2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1458			3	7·192	1·3	·000	·002	·004	·005	·007	–	–	·011	39,400	29,683	–	–	–	–	–	–	–	–	–	–	–	–	1·8	2·7	·1	2·6	8·	4·5	3·5	21·5	16·	5·5	–	–	–	25°·3
1459		Vertical. Slow	1	7·202	1·3	·001	·004	·005	·006	·010	–	–	·011	36,000	27,122	1·97	1·99	7·8013	·054	·003	·116	·013	–	–	·192	13,800	8,844	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1460			2	7·207	1·3	·001	·004	·005	·007	·009	–	–	·010	35,700	26,895	1·98	1·97	7·6831	·056	·002	·126	·018	–	–	·143	10,500	6,832	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1461			3	7·210	1·3	·001	·004	·007	·009	·010	–	–	·010	35,000	26,368	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·8	·6	2·2	8·4	4·8	3·6	–	–	–	–	–	–	19°·2
1462		Gradual	1	7·200	1·3	·001	·004	·006	·008	·011	–	–	·013	36,700	27,649	1·99	1·98	7·8015	·056	·004	·120	·015	–	–	·145	11,300	7,242	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1463			2	7·210	1·3	·002	·004	·006	·008	·011	–	–	·012	35,900	27,046	1·98	2·00	7,9200	·056	·004	·121	·014	–	–	·172	12,500	7,891	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1464			3	7·088	1·3	·000	·002	·004	·006	–	–	–	·007	34,000	25,615	–	–	–	–	–	–	–	–	–	–	–	–	1·8	–	–	–	–	–	–	–	–	–	–	–	–	3°·8
1465		Quick	1	7·198	1·3	·000	·004	·006	·007	–	–	–	·008	35,000	26,368	1·99	2·04	8,2815	·059	·007	·124	·019	–	–	·173	12,000	7,244	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1466			2	7·199	1·3	·002	·005	·008	·010	–	–	–	·012	32,500	24,636	1·98	1·99	7·8409	·060	·005	–	–	–	–	·121	9,000*	5,739*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1467			3	7·192	1·296	·001	·005	·007	·009	–	–	–	·013	34,000	25,615	–	–	–	–	–	–	–	–	–	–	–	–	1·795	2·	·0	2·	8·	3·5	4·5	–	–	–	–	–	–	10°·4
	GENERAL MEAN			7·195	1·3	·001	·004	·006	·007	·010	–	–	·011	35,870	27,033	1·99	2·00	7·9600	·055	·003	·119	·014	–	–	·168	12,327*	7,778*	1·748	2·3	·1	2·2	8·2	4·3	3·9	21·5	16·	5·5	–	–	–	16°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 27, at the end.

PARK HEAD FURNACES, NEAR DUDLEY.

PIG (COLD BLAST).

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·89
Silicon	0·96
Sulphur	0·06
Phosphorus	0·58
Manganese	0·55

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·195	26,619	8,701	7,943	94,431	11·883	3·884	3·546	42·156
1,850	7,943	36°	2·00	1·3	·6	2·16	·025	·011	·014	·049	·025	·024	·089	·060	·029	-	-	-	-	-	-	26,700	94,431									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·206	27,774	8,007	8,099	93,724	12·399	3·574	3·615	41·841
1,880	8,099	40°	2·19	1·3	·6	2·16	·025	·011	·014	·048	·027	·021	·084	·055	·029	-	-	-	-	-	-	26,500	93,724									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·204	29,532	8,354	8,787	96,553	13·183	3·729	3·922	43·102
2,050	8,787	36°	2·20	1·3	·6	2·16	·023	·011	·012	·046	·026	·020	·082	·052	·030	-	-	-	-	-	-	27,300	96,553									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·206	26,795	7,838	7,970	94,078	11·962	3·499	3·558	41·999
1,850	7,970	36°	2·11	1·3	·6	2·16	·023	·009	·014	·045	·025	·020	·087	·056	·031	-	-	-	-	-	-	26,600	94,078									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·166	26,770	7,566	3,858*	99,029	11·950	3·377	1·722*	44·205
900*	3,858*	33°	1·50	1·3	·6	2·16	·019	·007	·012	·042	·021	·021	·079	·051	·028	-	-	-	-	-	-	28,000	99,029									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·196	25,539	6,491*	6,700	96,907	11·401	2·897*	2·991	43·262
1,550	6,700	36°	1·86	-	-	-	·021	·008	·013	0·45	·022	·023	·080	·051	·029	-	-	-	-	-	-	27,400	96,907									
1,680*	7,226*	36°	1·97	1·3	·6	2·16	·023	·010	·013	·046	·024	·022	·084	·054	·030	-	-	-	-	-	-	27,083	95,787	7·195	27,033	7,778*	7,226*	95,787	12 064	3·472*	3·223*	42·762
Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - -																							7·201	27,780	8,354	8,276	94,903	12·401	3·729	3·694	42·367
Vertical - - - -																							7·189	26,368	7,298*	6,176*	96,671	11·771	3·258*	2·757*	43·156
Horizontally and Vertically cast - - - Slow - - - - -																							7·200	26,707	8,269	7,956	94,255	11·922	3·691	3·551	42·081
Gradual - - - -																							7·186	27,272	7,786	5,978*	91,877	12·175	3·471	2·668*	41·016
Quick - - - -																							7·200	27,595	7,422*	7,743	96,730	12·292	3·313*	3·456	43·183
Ratio in terms of the Crushing Force - - -																												·282	·081	·075	1·000

MESSRS. EVERS AND MARTIN,

GREY

MANUFACTURE.

Foundry pig iron manufactured from clay ironstone, coke, and limestone, smelted by cold blast, and of the first melting. The pigs are made from the following materials; viz.—

- Bottom stone and binds, from whitestone strata
- Gubbin and rubble, from gubbin strata
- Thick or 10-yard coal cokes
- Heathen coal cokes

The limestone is the produce of the Dudley quarries.

Cast - - - 3 October 1856.
Barometer - - - 29·87
Thermometer - - - 67·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	3	2	22
Runners	0	2	23
Slag and waste	0	3	7
Coals consumed	3	0	22

Time of—	hrs.	min.
Melting	1	0
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	Breaking Weight. At time of Breaking.	Observed.	Reduced to per Square Inch.
1468			1	7·133	1·3	·002	·006	–	–	–	–	–	·010	23,500	17,704
1469	Mark $\frac{10}{2}$. B	Slow -	2	7·092	1·3	·003	·006	·011	–	–	–	–	·013	26,400	19,889
1470			3	7·105	1·3	·003	·006	·010	–	–	–	–	·013	26,000	19,588
1471	CAST. 3 October 1856.		1	7·140	1·3	·003	·006	·010	–	–	–	–	·011	26,100	19,663
1472		Gradual	2	7·104	1·3	·002	·005	–	–	–	–	–	·007	22,600	17,026
1473	TESTED. Tensile, 9 Oct. 1857.		3	7·133	1·3	·003	·005	·010	–	–	–	–	·011	25,600	19,286
1474	Temp. 58°.		1	7·133	1·3	·001	·004	·010	–	–	–	–	·010	25,000	18,834
1475	Transverse, 5 Aug. 1857.	Quick -	2	6·829	1·3	·003	·008	·012	–	–	–	–	·017	27,900	21,019
1476	Temp. 72°.		3	7·117	1·3	·003	·007	·011	–	–	–	–	·013	26,200	19,738
1477	Torsion, 14 Aug. 1857. Temp. 69°.		1	7·027	1·3	·001	·005	–	–	–	–	–	·009	22,500	16,950
1478		Slow -	2	–	–	–	–	–	–	–	–	–	–	–	–
1479	Crushing, 27 Jan. 1859. Temp. 57°.		3	7·058	1·3	·000	·002	–	–	–	–	–	·008	24,100	18,156
1480	FRACTURE.		1	7·091	1·299	·001	·005	–	–	–	–	–	·009	24,700	18,637
1481	Light Grey. Bright.	Gradual	2	7·073	1·3	·000	·003	–	–	–	–	–	·010	24,600	18,533
1482	Regular. Medium Grain.		3	7·059	1·3	·000	·003	·009	–	–	–	–	·010	25,300	19,060
1483	Good working qualities.		1	7·106	1·3	·002	·005	–	–	–	–	–	·008	24,600	18,533
1484		Quick -	2	7·066	1·3	·000	·002	·007	–	–	–	–	·010	24,900	18,759
1485			3	7·129	1·3	·001	·004	–	–	–	–	–	·011	24,900	18,759
		Horizontal.													
		Vertical.													
	GENERAL MEAN - - -			7·082	1·3	·001	·005	·010	–	–	–	–	·010	24,994	18,831

TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
2·02	2·03	8·3642	·064	·004	·142	·020	–	–	·181	11,300	6,787
1·98	1·99	7·8409	·066	·006	–	–	–	–	·140	9,500	6,057
–	–	–	–	–	–	–	–	–	–	–	–
2·04	1·99	8·0786	·066	·005	·141	·021	–	–	·172	11,800	7,303
2·04	1·98	7·9976	·063	·002	·142	·020	–	–	·155	10,500	6,564
–	–	–	–	–	–	–	–	–	–	–	–
2·05	1·94	7·7153	·065	·005	·140	·015	–	–	·160	11,000	7,128
2·03	2·00	8·1200	·065	·010	·146	·020	–	–	·164	11,500	7,081
–	–	–	–	–	–	–	–	–	–	–	–
2·01	1·99	7·9598	·072	·012	–	–	–	–	·125	7,500	4,711
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
1·99	2·01	8·0397	·065	·006	–	–	–	–	·110	7,300	4,539
1·97	1·98	7·7231	·065	·004	–	–	–	–	·106	7,200	4,661
–	–	–	–	–	–	–	–	–	–	–	–
2·00	2·03	8·2418	·064	·005	–	–	–	–	·130	8,500	5,156
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
2·01	1·99	7·9598	·065	·005	·142	·019	–	–	·144	9,610	5,998

TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·796	4·	1·	3·	–	–	–	–	–	–	–	–	–	4°·
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·796	3·5	·5	3·	12·	7·	5·	–	–	–	–	–	–	15°·
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·799	3·2	·3	2·9	–	–	–	–	–	–	–	–	–	7°·
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	5·	1·1	3·9	–	–	–	–	–	–	–	–	–	14°·4
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·795	3·	·1	2·9	–	–	–	–	–	–	–	–	–	8°·8
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
1·797	3·6	·1	3·5	10·5	4·7	5·8	–	–	–	–	–	–	14·°3
1·797	3·7	·5	3·2	11·2	6·3	4·9	–	–	–	–	–	–	10°·6

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 28, at the end.

PARK HEAD FURNACES, NEAR DUDLEY.

FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·90
Silicon	1·63
Sulphur	0·03
Phosphorus	0·55
Manganese	0·95

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,010	4,358	37°	1·77	1·3	·6	2·16	·030	·015	·015	-	-	-	-	-	-	-	-	-	-	-	-	10,100	67,552	7·110	19,060	6,422	4,358	67,552	8·508	2·867	1·945	30·157
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,550	6,688	38°	2·19	1·3	·6	2·16	·030	·015	·015	-	-	-	-	-	-	-	-	-	-	-	-	10,600	69,320	7·125	18,658	6,033	6,688	69,320	8·329	3·095	2·985	30·946
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,450	6,226	40°	1·80	1·3	·6	2·16	·025	·009	·016	·057	·035	·022	-	-	-	-	-	-	-	-	-	14,800	77,101	7·026	19,863	7,104	6,226	77,101	8·867	3·171	2·779	34·420
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,410	6,074	40°	2·05	1·3	·6	2·16	·034	·020	·014	-	-	-	-	-	-	-	-	-	-	-	-	13,000	63,661	7·042	17,553	4,711	6,074	63,661	7·836	2·103	2·711	28·420
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,360	5,878	35°	2·15	1·3	·6	2·16	·029	·015	·014	-	-	-	-	-	-	-	-	-	-	-	-	14,900	70,381	7·074	18,743	4,600	5,878	70,381	8·367	2·053	2·624	31·420
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,530	6,591	36°	2·10	1·3	·6	2·16	·028	·013	·015	-	-	-	-	-	-	-	-	-	-	-	-	14,900	70,381	7·100	18,683	5,156	6,591	70,381	8·340	2·301	2·042	31·420
1,385	5,969	37°	2·01	1·3	·6	2·16	·029	·014	·015	·057	·035	·022	-	-	-	-	-	-	-	-	-	14,717	69,733	7·082	18,831	5,998	5,969	69,733	8·406	2·677	2·664	31·121
Combined Means - - -																								Slow, Gradual, and Quick cooling - - -										
																								Horizontal - - -		7·087	19,194	6,820	5,757	71,324	8·568	3·044	2·570	31·841
																								Vertical - - - -		7·076	18,423	4,766	6,181	68,141	8·224	2·127	2·759	30·419
																								Horizontally and Vertically cast - - -	Slow - - - - -	7·076	18,306	5,566	5,216	65,607	8·172	2·484	2·328	29·288
																									Gradual - - -	7·099	18,700	5,766	6,283	69,851	8·348	2·574	2·804	31·183
																									Quick - - - -	7·063	19,273	6,130	6,408	73,741	8·604	2·737	2·860	32·920
																													Ratio in terms of the Crushing Force - - -				·270	·086	·085	1·000

MESSRS. EVERS AND MARTIN,

FORGE

MANUFACTURE.

Foundry pig iron manufactured from clay ironstone, coke, and limestone, smelted by cold blast, and of the first melting. The pigs are made from the following materials; viz.—

- Bottom stone and binds, from whitestone strata
- Gubbin and rubble, from gubbin strata
- Thick or 10-yard coal cokes
- Heathen coal cokes

The limestone is the produce of the Dudley quarries.

CASTING.

Cast	3 October 1856.
Barometer	29·87
Thermometer	67°

Weight of—	cwt.	qrs.	lbs.
Charge	4	3	21
Castings	4	0	3
Runners	0	1	8½
Slag and waste	1	0	7
Coals consumed	4	0	22

Time of—	hrs.	min.
Melting	1	25
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1486			1	7·210	1·3	·001	·003	·005	·006	·009	·011	–	·011	44,600	33,601
1487	Mark $\frac{10}{3}$. C.	Slow	2	7·230	1·296	·001	·004	·007	·009	·013	–	–	·014	37,000	28,047
1488			3	7·210	1·3	·000	·002	·004	·005	·006	·009	–	·012	40,900	30,813
1489	CAST. 3 October 1856.		1	7·042	1·3	·003	·006	·008	·011	·014	·020	–	·021	40,900	30,813
1490		Gradual	2	7·206	1·3	·003	·005	·008	·010	·012	–	–	·015	39,000	29,382
1491	TESTED. Tensile, 9 Oct. 1857.		3	7·206	1·3	·000	·003	·004	·006	·009	–	–	·014	40,000	30,135
1492	Temp. 58°.		1	7·215	1·3	·002	·005	·006	·008	·010	·013	–	·016	43,000	32,395
1493	Transverse, 5 Aug. 1857.	Quick	2	7·214	1·3	·000	·002	·003	·005	·006	·008	–	·010	44,000	33,149
1494	Temp. 72°.		3	7·222	1·3	·001	·005	·007	·008	·010	·011	–	·014	43,100	32,470
1495	Torsion, 13 Oct. 1857. Temp. 65°.		1	7·133	1·3	·001	·004	·005	·007	·010	–	–	·011	40,000	30,135
1496		Slow	2	7·181	1·3	·000	·002	·004	·005	·007	–	–	·008	39,000	29,382
1497	Crushing, 31 Jan. 1859. Temp. 56°.		3	7·143	1·3	·000	·002	·004	·006	·008	–	–	·010	39,900	30,060
1498			1	7·192	1·3	·003	·006	·009	·010	·012	–	–	·014	37,000	27,875
1499	FRACTURE. Light Grey.	Gradual	2	7·210	1·3	·000	·002	·005	·007	·009	–	–	·010	37,000	27,875
1500	Bluish. Regular.		3	7·179	1·3	·002	·005	·008	·009	·012	–	–	·014	37,000	27,875
1501	Fine Grain.		1	7·211	1·3	·001	·003	·005	·007	·010	·012	–	·014	44,900	33,827
1502	Good working qualities.	Quick	2	7·210	1·3	·002	·004	·005	·007	·008	·010	–	·011	40,500	30,511
1503			3	7·227	1·3	·002	·004	·007	·008	·011	·014	–	·015	42,000	31,642
	GENERAL MEAN			7·193	1·3	·001	·003	·005	·007	·009	·012	–	·013	40,544	30,554

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1486	2·02	2·02	8·2420	·053	·005	·110	·012	·180	·030	·190	15,100	9,159	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1487	1·99	2·00	7·9600	·055	·006	·116	·018	·181	·040	·200	15,300	9,610	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1488	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·3	·1	2·2	5·2	2·8	2·4	17·	12·	5·	–	–	–	17°·9
1489	1·98	2·02	8·0791	·048	·003	·106	·010	–	–	·182	14,000	8,664	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1490	2·01	1·97	7·8006	·050	·001	·115	·010	–	–	·199	14,400	9,230	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1491	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·	·0	2·	7·	3·2	3·8	–	–	–	–	–	–	9°·
1492	2·00	1·94	7·5272	·054	·002	·114	·007	–	–	·167	13,500	8,967	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1493	2·00	2·00	8·0000	·053	·003	·106	·006	·171	·019	·200	16,800	10,500	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1494	–	–	–	–	–	–	–	–	–	–	–	–	1·796	1·2	·0	1·2	3·5	1·	2·5	–	–	–	–	–	–	9°·2
1495	1·97	1·96	7·5679	·062	·006	·130	·020	–	–	·145	10,500	6,937	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1496	1·97	1·97	7·6453	·062	·006	·130	·021	–	–	·190	13,200	8,632	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1497	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·1	·1	2·	7·6	3·7	3·9	–	–	–	–	–	–	9°·7
1498	1·99	2·01	8·0397	·055	·004	·119	·017	–	–	·150	11,600	7,214	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1499	1·96	1·98	7·6839	·054	·003	·116	·012	–	–	·182	13,690	8,849	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1500	–	–	–	–	–	–	–	–	–	–	–	–	1·796	1·8	·0	1·8	7·4	3·2	4·2	–	–	–	–	–	–	9°·7
1501	1·98	1·98	7·7623	·054	·003	·106	·010	·175	·012	·250	16,600	10,692	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1502	1·96	1·96	7·5295	·060	·009	·120	·018	–	–	·145	11,500*	7,636*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1503	–	–	–	–	–	–	–	–	–	–	–	–	1·795	2·	·1	1·9	5·1	1·7	3·4	–	–	–	–	–	–	15°·
	1·99	1·98	7·8015	·055	·004	·115	·013	·176	·025	·183	13,842*	8,840*	1·796	1·9	·1	1·8	5·9	2·6	3·3	17·	12·	5·	–	–	–	11°·7

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 29, at the end.

PARK HEAD FURNACES, NEAR DUDLEY.

PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·00
Silicon	1·21
Sulphur	0·10
Phosphorus	0·48
Manganese	0·86

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
2,010	8,673	35°	1·85	1·3	·6	2·16	·020	·005	·015	·039	·017	·022	·068	·039	·029	·125	·091	·034	–	–	–	30,500	107,871	7·216	30,820	9,384	8,673	107,871	13·758	4·189	3·871	48·156
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,650*	7,096*	37°	2·20	1·3	·6	2·16	·019	·008	·011	·043	·022	·021	·073	·048	·025	·159	·125	·034	–	–	–	30,600	108,225	7·151	30,110	8,947	7,096*	108,225	13·441	3·994	3·167*	48·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,930	8,328	40°	1·76	1·3	·6	2·16	·015	·001	·014	·029	·008	·021	·050	·021	·029	·080	·043	·037	–	–	–	33,600	118,835	7·217	32,671	9,733	8,328	118,835	14·585	4·345	3·717	53·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,570	6,752	40°	1·68	1·3	·6	2·16	·023	·009	·014	·045	·024	·021	·078	·050	·028	–	–	–	–	–	–	27,800	98,322	7·165	29,859	7,784	6,752	98,322	13·329	3·475	3·014	43·892
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,550*	6,688*	37°	2·00	1·3	·6	2·16	·020	·011	·009	·048	·029	·019	·083	·056	·027	–	–	–	–	–	–	27,900	98,675	7·193	27,875	8,031	6,688*	98,675	12·444	3·585	2·985*	44·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
2,000	8,645	39°	2·10	1·3	·6	2·16	·017	·004	·013	·037	·014	·023	·058	·030	·028	·100	·063	·037	–	–	–	31,500	111,408	7·216	31,993	9,164*	8,645	111,408	14·282	4·091*	3·859	49·735
1,785*	7,697*	38°	1·93	1·3	·6	2·16	·019	·006	·013	·040	·019	·021	·068	·041	·027	·116	·080	·036	–	–	–	30,317	107,223	7·193	30,554	8,840*	7,697*	107,223	13·640	3·940*	3·436*	47·866
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·195	31,200	9,355	8,032*	111,644	13·928	4·176	3·585*	49·841
Vertical - - - -																								7·191	29,909	8,326*	7,361*	102,802	13·352	3·716*	3·286*	45·893
Horizontally and Vertically cast - - - Slow - - - - -																								7·191	30,339	8,584	7,712	103,097	13·544	3·832	3·442	46·025
Gradual - - - -																								7·172	28,992	8,489	6,892*	103,450	12·942	3·789	3·076*	46·183
Quick - - - -																								7·217	32,332	9,448*	8,486	115,122	14·433	4·217*	3·788	53·937
Ratio in Terms of the Crushing Force - - -																													·284	·082	·071	1·000

PARK HEAD FURNACES, DUDLEY.

(Messrs. Evers & Martin.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores.

The samples of ironstone received had all been previously calcined. They were stated to be employed in the cold blast furnace in the proportion of two-thirds "Bottom stone" and "Binds," and one-third "Gubbin" and "Rubble."

"*Bottom stone*" and "*Binds*" from the New Mine, whitestone strata.

Average samples contained of—

	Bottom Stone.	Binds.
Metallic iron - - - - - -	57·10	54·43
Phosphoric acid - - - - -	0·78	0·67
Burnt clay (insoluble in hydrochloric acid)	13·42	12·18

"*Gubbin*" and "*Rubble*" black ironstones, found in the Gubbin strata.

Average samples contained of—

	Gubbin.	Rubble.
Metallic iron - - - - - -	59·87	47·93
Phosphoric acid - - - - -	0·62	0·52
Burnt clay (insoluble in hydrochloric acid)	12·50	24·30

Fuel.

Cokes made from the Staffordshire "Ten Yard" or "Thick" coal, and the "Heathen" coal lying immediately under the Gubbin strata, employed in the proportion of three-fifths of the former to two-fifths of the latter.

"*Thick*" *or* "*Ten Yard Coal*" *Coke.*—An average sample of the coke contained—

Sulphur - - - - - - - - 0·40 per cent.

and left, on burning—

Ash - - - - - - - - 3·78 per cent.

The ash consisted of burnt shale, *silicate of alumina*, with *peroxide of iron*, and very little *lime* and *magnesia*.

Heathen Coal Coke.—An average sample contained—

Sulphur - - - - - - - - 0·51 per cent.

and left, on burning,

Ash - - - - - - - - 4·58 per cent.

The ash consisting of *silica*, *alumina*, with *peroxide of iron*, and traces only of *lime* and *magnesia*.

PARK HEAD FURNACES, DUDLEY—*continued.*

FLUX.

Limestone from the Dudley Quarries.—Of the same character as that employed at the Netherton Works (series preceding), and having a similar composition.

(Sample dried at 212° Fahrenheit.)

Carbonate of lime	97·10
Carbonate of magnesia	0·85
Carbonate of iron	0·60
Sand and clay	1·15
Water and loss	0·30
	100·00

IRONS.

Cold Blast Pig Irons.

Important Constituents in 100 *Parts.*

	I. No. 1, Pig Iron.	II. Grey Forge.	III. Forge.
Carbon, as graphite	2·89	2·90	3·00
Silicon	0·96	1·63	1·21
Sulphur	0·06	0·03	0·10
Phosphorus	0·58	0·55	0·48
Manganese	0·55	0·95	0·86

Note.—The analyses I. and II. were made upon the square bars cast for submission to mechanical tests, that of III. from the original pig.

Remark.—Other samples of iron, representing supplies from these works, are given in the Appendix.

MESSRS. BADGER AND COMPANY,

No. 2.—

MANUFACTURE.

Smelted and manufactured with the following materials, viz.:—Whitestone, gubbinstone, grains, pins, balls, and poor robins, with a small portion of red ore from the Ulverstone Mines; thick coal coke from the Old Hill Collieries, and limestone, the produce of T. & J. Badger's Springfield Mine.

CASTING.

Cast	29 September 1856.
Barometer	29·18
Thermometer	65°

Weight of—	cwt.	qrs.	lbs.
Charge	4	2	24
Castings	3	2	12½
Runners	0	2	24
Slag and waste	0	1	7
Coals consumed	5	2	1

Time of—	hrs.	min.
Melting	1	0
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1270	Mark $\frac{7}{1}$.	Horizontal. Slow	1	6·959	1·3	·002	–	–	–	–	–	–	·008	19,500	14,691	1·99	1·99	7·8805	·070	·005	–	–	–	–	·144	8,500	5,392	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1271			2	6·952	1·3	·002	–	–	–	–	–	–	·007	19,600	14,766	2·01	2·01	8·1206	·065	·002	–	–	–	–	·138	8,500	5,233	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1272	CAST.		3	6·952	1·3	·003	–	–	–	–	–	–	·008	19,600	14,766	–	–	–	–	–	–	–	–	–	–	–	–	1·8	7·3	3·	4·3	–	–	–	–	–	–	–	–	–	–	13°·
1273	29 September 1856.	Horizontal. Gradual	1	6·960	1·3	·003	–	–	–	–	–	–	·010	19,200	14,464	1·97	2·04	8·1983	·062	·002	–	–	–	–	·138	8,600	5,244	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1274	TESTED.		2	6·943	1·3	·004	–	–	–	–	–	–	·011	19,900	14,992	2·01	1·97	7·8006	·065	·002	–	–	–	–	·138	8,500	5,448	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1275	Tensile, 8 June 1857. Temp. 68°.		3	6·959	1·3	·004	–	–	–	–	–	–	·010	19,400	14,615	–	–	–	–	–	–	–	–	–	–	–	–	1·798	–	–	–	–	–	–	–	–	–	–	–	–	–	5°·4
1276	Transverse, 17 April 1857.		1	7·001	1·3	·003	·010	–	–	–	–	–	·011	20,100	15,142	2·00	2·02	8·1608	·061	·000	–	–	–	–	·142	9,700	5,943	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1277	Temp. 57°.	Quick	2	6·98	1·3	·003	–	–	–	–	–	–	·009	19,900	14,992	2·02	2·00	8·0800	·068	·000	–	–	–	–	·120	8,000	4,950	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1278	Torsion, 6 May 1857.		3	6·960	1·3	·003	·011	–	–	–	–	–	·012	20,100	15,142	–	–	–	–	–	–	–	–	–	–	–	–	1·8	6·	1·4	4·6	–	–	–	–	–	–	–	–	–	–	9°·4
1279	Temp. 57°.		1	6·951	1·296	·003	–	–	–	–	–	–	·008	19,000	14,402	1·96	1·98	7·6839	·056	·000	–	–	–	–	·130	8,300	5,400	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1280	Crushing, 31 Jan. 1859.	Vertical. Slow	2	6·931	1·293	·004	–	–	–	–	–	–	·012	19,900	15,155	1·97	1·99	7·8013	·067	·000	–	–	–	–	·129	7,700	4,935	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1281	Temp. 56°.		3	6·918	1·3	·002	–	–	–	–	–	–	·003	18,000	13,561	–	–	–	–	–	–	–	–	–	–	–	–	1·8	10·	5·7	4·3	–	–	–	–	–	–	–	–	–	–	13°·6
1282	FRACTURE. Medium Grey.		1	6·922	1·3	·004	–	–	–	–	–	–	·011	19,400	14,615	1·98	1·98	7·7623	·072	·002	–	–	–	–	·109	6,800*	4,380*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1283	Bright.	Gradual	2	6·940	1·3	·004	–	–	–	–	–	–	·009	17,500	13,184	2·00	2·00	8·0000	·075	·005	–	–	–	–	·140	8,200	5,125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1284	Regular. Fine Grain.		3	6·932	1·3	·003	–	–	–	–	–	–	·009	18,500	13,938	–	–	–	–	–	–	–	–	–	–	–	–	1·799	–	–	–	–	–	–	–	–	–	–	–	–	–	9°·2
1285	Good working qualities.		1	6·996	1·3	·003	·009	–	–	–	–	–	·009	20,000	15,067	1·99	1·98	7·8015	·068	·003	–	–	–	–	·138	7,900	5,063	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1286		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1287			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			6·949	1·299	·003	·010	–	–	–	–	–	·009	19,350	14,593	1·99	1·99	7·8805	·066	·002	–	–	–	–	·133	8,245*	5,192*	1·799	7·7	3·3	4·4	–	–	–	–	–	–	–	–	–	–	10°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 30, at the end.

OLD HILL FURNACES, NEAR DUDLEY.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·06
Silicon	3·48
Sulphur	0·03
Phosphorus	0·38
Manganese	0·30

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200	5,144	36°	1·90	1·3	·6	2·16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13,900	49,161	6·954	14,741	5,312	5,144	49,161	6·580	2·371	2·296	21·946
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
960*	4,128*	35°	2·22	1·3	·599	2·17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14,000	49,680	6·954	14,690	5,346	4,128*	49,680	6·558	2·386	1·842*	22·178
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200	5,144	38°	2·22	1·3	·6	2·16	·053	·037	·016	-	-	-	-	-	-	-	-	-	-	-	-	15,800	55,880	6·956	15,092	5,446	5,144	55,880	6·737	2·431	2·296	24·946
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,100	4,715	30°	1·60	1·3	·6	2·16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13,800	48,807	6·933	14,372	5,167	4,715	48,807	6·416	2·306	2·104	21·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
950*	4,079	37°	1·94	1·3	·599	2·17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13,800	48,970	6·931	13,912	4,752*	4,079*	48,970	6·210	2·121*	1·820*	21·861
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·996	15,067	5,063	- -	- -	6·726	2·260	—	—
1,082*	4,642*	35°	1·97	1·3	·6	2·16	·053	·037	·016	-	-	-	-	-	-	-	-	-	-	-	-	14,260	50,499	6·949	14,593	5,192*	4,642*	50,499	6·514	2·317*	2·072*	22·544
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								6·954	14,841	5,368	4,805*	51,574	6·625	2·396	2·145*	23·024
Vertical - - - -																								6·941	14,274	4,980*	4,397*	48,889	6·372	2·223*	1·962*	21·825
Horizontally and Vertically cast - - - Slow - - - - -																								6·944	14,556	5,239	4,929	48,984	6·498	2·338	2·200	21·867
Gradual - - - -																								6·943*	14,301	5,049*	4,103*	49,325	6·384	2·254*	1·831*	22·020
Quick - - - -																								6·978	15,079	5,254	5,144	55,880	6·731	2·345	2·296	24·946
Ratio in terms of the Crushing Force - - -																													·288	·102	·091	1·000

MESSRS. BADGER AND CO.

No. 3.

MANUFACTURE.

Smelted and manufactured with the following materials, viz.:—Whitestone, gubbinstone, grains, pins, balls, and poor robins, with a small portion of red ore from the Ulverstone Mines; thick coal coke from the Old Hill Collieries, and limestone the produce of T. & J. Badger's Springfield Mine.

CASTING.

Cast	30 September 1856.
Barometer	29·63
Thermometer	66·

Weight of—	cwts.	qrs.	lbs.
Charge	4	3	12
Castings	4	0	22
Runners	0	1	9
Slag and waste	0	1	20
Coals consumed	3	3	17

Time of—	hrs.	min.
Melting	0	45
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1288	Mark $\frac{7}{2}$.	Horizontal. Slow	1	7·117	1·3	·002	·005	·008	·010	–	–	–	·011	32,200	24,259
1289			2	7·118	1·3	·003	·005	·008	·010	–	–	–	·011	31,200	23,506
1290	CAST.		3	7·123	1·3	·001	·003	·005	·007	–	–	–	·009	32,100	24,183
1291	30 September 1856.		1	7·115	1·3	·002	·005	·007	·010	–	–	–	·011	32,700	24,635
1292	TESTED.	Gradual	2	7·129	1·3	·001	·004	·006	·009	–	–	–	·009	30,000	22,601
1293	Tensile, 9 June 1857.		3	7·109	1·3	·003	·007	·010	·012	–	–	–	·013	31,300	23,581
1294	Temp. 65°.		1	7·069	1·3	·000	·004	·005	·008	–	–	–	·009	32,600	24,560
1295	Transverse, 17 April 1857.	Quick	2	7·122	1·3	·001	·005	·008	·010	–	–	–	·014	34,500	25,992
1296	Temp. 57°.		3	7·109	1·3	·001	·003	·005	·007	–	–	–	·010	32,400	24,409
1297	Torsion, 6 May 1857.		1	7·098	1·3	·003	·004	·006	·008	–	–	–	·009	31,300	23,581
1298	Temp. 58°.	Slow	2	7·129	1·3	·003	·006	·008	·010	–	–	–	·010	30,000	22,601
1299	Crushing, 31 Jan. 1859.		3	7·114	1·3	·003	·008	·011	·013	–	–	–	·014	30,800	23,204
1300	Temp. 56°.	Vertical.	1	7·109	1·3	·002	·005	·008	·011	–	–	–	·012	30,900	23,279
1301	FRACTURE. Light Grey. Bright.	Gradual	2	7·094	1·3	·001	·004	·006	·009	–	–	–	·010	31,000	23,355
1302	Regular. Fine Grain.		3	7·101	1·3	·001	·004	·006	–	–	–	–	·008	29,500	22,225
1303	Tolerable working qualities.	Quick	1	7·106	1·3	·000	·003	·006	·008	–	–	–	·009	31,900	24,033
1304			2	7·128	1·3	·002	·006	·009	·014	–	–	–	·015	31,800	23,958
1305			3	7·117	1·3	·001	·004	·006	·009	–	–	–	·011	32,800	24,711
	GENERAL MEAN			7·111	1·3	·002	·005	·007	·010	–	–	–	·011	31,611	23,815

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1288	2·01	1·95	7·6430	·056	·003	·130	·012	–	–	·176	12,500	8,177
1289	1·99	2·04	8·2815	·056	·003	·127	·015	–	–	·192	13,200	7,969
1290	–	–	–	–	–	–	–	–	–	–	–	–
1291	2·00	2·05	8·4050	·055	·002	·123	·014	–	–	·193	13,500	8,030
1292	2·03	2·04	8·4480	·053	·004	·132	·016	–	–	·192	12,700	7,516
1293	–	–	–	–	–	–	–	–	–	–	–	–
1294	2·03	2·01	8·2014	·055	·007	·127	·018	–	–	·163	12,300	7,498
1295	2·02	2·02	8·2420	·052	·002	·122	·011	–	–	·200	14,100	8,553
1296	–	–	–	–	–	–	–	–	–	–	–	–
1297	1·97	1·97	7·6453	·056	·001	–	–	–	–	·140	10,000	6,539
1298	1·97	1·96	7·5679	·057	·005	·145	·018	–	–	·157	10,600	7,003
1299	–	–	–	–	–	–	–	–	–	–	–	–
1300	1·99	1·99	7·8805	·056	·003	·133	·012	–	–	·143	10,800	6,852
1301	1·99	2·03	8·2005	·056	·001	·130	·011	–	–	·145	10,700	6,523
1302	–	–	–	–	–	–	–	–	–	–	–	–
1303	1·98	2·01	7·9993	·053	·000	·120	·010	–	–	·162	12,700	7,938
1304	1·98	2·00	7·9200	·050	·000	·123	·008	–	–	·145	11,300	7,133
1305	–	–	–	–	–	–	–	–	–	–	–	–
	2·00	2·00	8·0000	·055	·003	·128	·013	–	–	·167	12,033	7,478

Register No.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1288	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1289	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1290	1·8	3·	·5	2·5	9·3	3·8	5·5	–	–	–	–	–	–	11°·2
1291	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1292	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1293	1·8	3·	·6	2·4	8·7	4·5	4·2	–	–	–	–	–	–	14°·6
1294	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1295	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1296	1·8	3·5	·5	3·	8·3	3·3	5·	–	–	–	–	–	–	11°·3
1297	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1298	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1299	1·796	3·7	·7	3·	9·7	4·9	4·8	–	–	–	–	–	–	13°·6
1300	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1301	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1302	1·796	3·	·4	2·6	8·	3·6	4·4	–	–	–	–	–	–	13°·6
1303	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1304	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1305	1·797	3·3	·8	2·5	8·4	4·	4·4	–	–	–	–	–	–	16°·8
	1·798	3·2	·6	2·6	8·7	4·	4·7	–	–	–	–	–	–	13°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 31, at the end.

OLD HILL FURNACES, NEAR DUDLEY.

GREY FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·69
Silicon	2·24
Sulphur	0·04
Phosphorus	0·63
Manganese	0·34

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
1,600	6,858	35°	2·23	1·3	·6	2·16	·023	·010	·013	·059	·036	·023	-	-	-	-	-	-	-	-	-	22,800	80,638	7·119	23,982	8,073	6,858	80,638	10·706	3·604	3·061	35·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
1,680	7,201	38°	1·70	1·3	·6	2·16	·023	·011	·012	·058	·039	·019	-	-	-	-	-	-	-	-	-	22,300	78,869	7·117	23,605	7,773	7,201	78,869	10·537	3·470	3·214	35·209
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
1,620	6,944	39°	2·40	1·3	·6	2·16	·023	·011	·012	·050	·027	·023	-	-	-	-	-	-	-	-	-	22,500	83,114	7·100	24,987	8,026	6,944	83,114	11·154	3·584	3·100	37·104
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
1,610	6,947	35°	1·85	1·3	·6	2·16	·026	·015	·011	·057	·036	·021	-	-	-	-	-	-	-	-	-	22,800	80,638	7·113	23,128	6,771	6,947	80,638	10·325	3·022	3·101	35·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
1,680	7,266	38°	2·00	1·3	·6	2·16	·023	·014	·009	·059	·040	·019	-	-	-	-	-	-	-	-	-	22,800	80,638	7·101	22,953	6,687	7,266	80,638	10·246	2·985	3·243	35·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-								
1,780	7,668	35°	2·22	1·3	·6	2·16	·022	·010	·012	·053	·031	·022	-	-	-	-	-	-	-	-	-	23,200	82,053	7·117	24,234	7,535	7,668	82,053	10·818	3·363	3·423	36·630
1,661	7,147	37°	2·06	1·3	·6	2·16	·023	·012	·011	·056	·035	·021	-	-	-	-	-	-	-	-	-	22,900	80,991	7·111	23,815	7,478	7,147	80,991	10·631	3·338	3·190	36·156
Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - -																								7·112	24,191	7,957	7,001	80,873	10·799	3·552	3·125	36·102
Vertical - - - -																								7·111	23,438	6,998	7,293	81,110	10·463	3·124	3·255	36·209
Horizontally and Vertically cast - - - Slow - - - - -																								7·116	23,555	7,422	6,902	80,638	10·515	3·313	3·081	35·999
Gradual - - - -																								7·109	23,279	7,230	7,233	79,754	10·392	3·227	3·229	35·604
Quick - - - - -																								7·109	24,610	7,781	7,306	82,584	10·986	3·474	3·261	36·867
Ratio in terms of the Crushing Force - - -																													·294	·092	·088	1·000

MESSRS. BADGER AND CO.,

No. 4.—

MANUFACTURE.

Smelted and manufactured with the following materials, viz.:—Whitestone, gubbinstone, grains, pins, balls and poor robins, with a small portion of red ore from the Ulverstone Mines; thick coal coke from the Old Hill Collieries, and limestone, the produce of T. & J. Badger's Springfield Mine.

CASTING.

Cast - - 30 September 1856.
Barometer - - - 29·63
Thermometer - - - 66·

Weight of—	cwt.	qrs.	lbs.
Charge - -	4	1	0
Castings - -	3	0	20
Runners - -	0	1	8½
Slag and waste -	0	1	18
Coals consumed -	4	2	4

Time of—	hrs.	min.
Melting - - -	1	0
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1306			1	7·126	1·3	·002	·006	·008	–	–	–	–	·013	29,000	22,526
1307	Mark $\frac{7.}{3}$	Horizontal. Slow -	2	7·091	1·3	·002	·005	·007	·012	–	–	–	·012	30,000	22,601
1308			3	7·109	1·3	·002	·007	·010	–	–	–	–	·015	29,500	22,225
1309	CAST.		1	–	–	–	–	–	–	–	–	–	–	–	–
1310	30 September 1856.	Horizontal. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1311			3	–	–	–	–	–	–	–	–	–	–	–	–
	TESTED.														
1312	Tensile, 10 June 1857.		1	7·020	1·3	·003	·006	·009	·014	–	–	–	·015	30,900	23,279
1313	Temp. 64°.	Horizontal. Quick -	2	6·797	1·3	·002	·005	·008	·010	–	–	–	·012	32,800	24,711
1314	Transverse, 18 Apr. 1857.		3	7·138	1·3	·002	·006	·008	·010	–	–	–	·011	33,200	25,013
1315	Temp. 62°.		1	7·057	1·3	·003	·006	·009	·010	–	–	–	·013	30,300	22,827
1316	Torsion, 20 May 1857.	Vertical. Slow -	2	7·055	1·3	·003	·006	·008	·009	–	–	–	·010	30,900	23,279
1317	Temp. 67°.		3	7·071	1·3	·003	·007	·010	·018	–	–	–	·018	30,000	22,601
1318	Crushing, 31 Jan. 1859.		1	7·079	1·3	·001	·005	·007	–	–	–	–	·011	29,700	22,375
1319	Temp. 56°.	Vertical. Gradual	2	7·109	1·3	·002	·005	·007	–	–	–	–	·009	29,600	22,300
1320	FRACTURE.		3	7·031	1·3	·003	·007	·011	–	–	–	–	·013	29,400	22,149
1321	Light Grey.		1	7·050	1·3	·002	·005	·008	–	–	–	–	·010	29,900*	22,526*
1322	Regular. Medium Grain. Good working qualities.	Vertical. Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–
1323			3	7·088	1·3	·002	·005	·007	–	–	–	–	·009	29,800	22,451
	GENERAL MEAN - - -			7·058	1·3	·002	·006	·009	·012	–	–	–	·012	30,421*	22,918*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1306	2·03	2·02	8·2913	·050	·000	·120	·010	–	–	·192	13,200	8,128
1307	2·02	2·01	8·1610	·056	·005	·128	·016	–	–	·187	12,800	7,920
1308	–	–	–	–	–	–	–	–	–	–	–	–
1309	–	–	–	–	–	–	–	–	–	–	–	–
1310	–	–	–	–	–	–	–	–	–	–	–	–
1311	–	–	–	–	–	–	–	–	–	–	–	–
1312	2·01	2·00	8·0400	·051	·001	·122	·013	–	–	·159	12,000	7,462
1313	2·00	1·97	7·7618	·050	·000	·121	·012	–	–	·172	12,600	8,116
1314	–	–	–	–	–	–	–	–	–	–	–	–
1315	2·01	2·00	8·0400	·052	·000	–	–	–	–	·115	9,200	5,721
1316	2·02	2·00	8·0800	·055	·000	·148	·019	–	–	·148	10,400	6,435
1317	–	–	–	–	–	–	–	–	–	–	–	–
1318	1·99	2·01	8·0397	·055	·001	·140	·020	–	–	·152	10,700	6,654
1319	2·00	2·00	8·0000	·054	·000	–	–	–	–	·148	9,900	6,187
1320	–	–	–	–	–	–	–	–	–	–	–	–
1321	1·96	2·06	8·4447	·050	·000	–	–	–	–	·141	9,650	5,713
1322	–	–	–	–	–	–	–	–	–	–	–	–
1323	–	–	–	–	–	–	–	–	–	–	–	–
	2·00	2·01	8·0802	·052	·001	·129	·015	–	–	·157	11,161	6,926

TORSION. Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar.

Register No.	Diameter.	1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1306	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1307	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1308	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1309	1·797	4·	1·1	2·9	–	–	–	–	–	–	–	–	–	7°·6
1310	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1311	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1312	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1313	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1314	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1315	1·797	3·5	1·	2·5	–	–	–	–	–	–	–	–	–	10°·
1316	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1317	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1318	1·8	4·	1·1	2·9	–	–	–	–	–	–	–	–	–	9°·
1319	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1320	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1321	1·8	4·1	1·1	3·	–	–	–	–	–	–	–	–	–	8°·3
1322	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1323	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1·799	3·6	·8	2·8	–	–	–	–	–	–	–	–	–	8°·
	1·799	3·8	1·	2·8	–	–	–	–	–	–	–	–	–	8°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 32, at the end.

OLD HILL FURNACES, NEAR DUDLEY.

FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·76
Silicon	1·75
Sulphur	0·07
Phosphorus	0·55
Manganese	trace.

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of													Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·108	22,450	8,024	5,169*	77,808	10·022	3·582	2·307*	34·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200*	5,169*	27°	1·68	1·3	·6	2·16	·029	·015	·014	·071	·049	·022	-	-	-	-	-	-	-	-	-	22,000	77,808									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·985	24,334	7,789	6,419	70,028	10·863	3·476	2·865	31·262
1,490	6,419	41°	1·90	1·3	·6	2·16	·028	·016	·012	-	-	-	-	-	-	-	-	-	-	-	-	19,800	70,028									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·061	22,902	6,078	6,001*	79,223	10·224	8·713	2·679*	35·367
1,400*	6,001*	37°	1·90	1·3	·6	2·16	·027	·012	·015	·065	·045	·020	-	-	-	-	-	-	-	-	-	22,400	79,223									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·073	22,274	6,420	5,572	80,638	9·943	2·866	2·487	35·999
1,300	5,572	40°	1·96	1·3	·6	2·16	·025	·012	·013	·060	·040	·020	-	-	-	-	-	-	-	-	-	22,800	80,638									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·069	22,488*	5,713	5,624	93,370	10·039*	3·550	2·510	41·683
1,310	5,624	38°	1·90	1·3	·6	2·16	·025	·011	·014	·053	·031	·022	·117	·085	·032	-	-	-	-	-	-	26,400	93,370									
1,340	5,757	36°	1·85	1·3	·6	2·16	·027	·013	·014	·062	·041	·021	·117	·085	·032	-	-	-	-	-	-	22,680	80,213	7·058	22,918*	6,926	5,757*	80,213	10·231*	3·091	2·570*	35·809
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·046	23,392	7,906	5,794*	73,918	10·442	3·529	2·586*	32·999
Vertical - - - -																								7·067	22,563*	6,142	5,732*	84,410	10·072*	2·741	2·558*	37·683
Horizontally and Vertically cast - - - Slow - - - - -																								7·085	22,676	7,051	5,585*	78,516	10·123	3·147	2·493*	35·051
Gradual - - - -																								7·073	22,274	6,420	5,572	80,638	9·943	2·866	2·487	35·999
Quick - - - -																								7·027	23,411*	6,751	6,021	81,699	10,451*	3·013	2·687	36·472
Ratio in terms of the Crushing Force - - -																													·285	·086	·071	1·000

MESSRS. BADGER AND CO.,

STRONG

MANUFACTURE.

Smelted and manufactured with the following materials, viz.:—Whitestone, gubbinstone, grains, pins, balls and poor robins, with a small portion of red ore from the Ulverstone Mines, thick coal coke from the Old Hill Collieries, and limestone, the produce of T. and J. Badger's Springfield Mine.

CASTING.

Cast	30 September 1856.
Barometer	29·63
Thermometer	66·

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	3	3	26
Runners	0	2	21½
Slag and waste	0	3	19
Coals consumed	4	1	26

Time of—	hrs.	min.
Melting	1	10
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1324			1	7·232	1·3	·002	·006	·007	·008	·010	–	–	·011	36,300	27,348	1·97	2·04	8·1983	·047	·000	·103	·006	–	–	·157	13,500	8,233	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1325	Mark $\frac{7}{4}$.	Horizontal. Slow	2	7·228	1·3	·003	·005	·006	·007	·010	–	–	·011	36,800	27,725	2·01	1·97	7·8006	·045	·000	·105	·004	–	–	·175	14,400	9,230	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1326	CAST.		3	7·230	1·3	·002	·004	·005	·007	·008	–	–	·010	37,900	28,553	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·	0·	2·	4·7	1·7	3	–	–	–	–	–	–	8°·5
1327	30 September 1856.		1	7·171	1·3	·002	·004	·005	·007	·008	–	–	·012	39,900	30,060	2·00	1·95	7·6050	·052	·002	·101	·008	–	–	·200	15,000	9,861	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1328	TESTED.	Horizontal. Gradual	2	7·185	1·3	·003	·005	·007	·008	·011	–	–	·012	39,400	29,683	1·99	1·98	7·8015	·050	·002	·104	·013	–	–	·200	14,800*	9,485*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1329	Tensile, 10 June 1857. Temp. 64°.		3	7·184	1·3	·002	·005	·006	·007	·010	–	–	·011	39,900	30,060	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·3	·3	3·	7·2	2·8	4·4	–	–	–	–	–	–	10°·
1330			1	7·209	1·3	·001	·003	·004	·007	·009	–	–	·010	39,000	29,382	2·02	1·97	7·8394	·048	·000	·106	·007	–	–	·182	14,600	9,311	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1331	Transverse, 18 Apr. 1857. Temp. 62°.	Horizontal. Quick	2	7·194	1·3	·001	·003	·004	·007	·008	–	–	·010	39,100	29,457	2·02	1·95	7·6810	·049	·002	·115	·010	–	–	·178	14,000	9,113	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1332	Torsion, 20 May 1857.		3	7·213	1·3	·002	·004	·005	·008	·010	–	–	·012	39,700	29,909	–	–	–	–	–	–	–	–	–	–	–	–	1·799	1·8	·0	1·8	–	–	–	–	–	–	–	–	–	6°·6
1333	Temp. 67°.		1	7·206	1·3	·001	·003	·005	·007	·010	–	–	·011	36,000	27,122	1·99	2·00	7·9600	·048	·000	·116	·008	–	–	·121	10,500	6,595	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1334	Crushing, 31 Jan. 1859.	Vertical. Slow	2	6·594	1·3	·002	·005	–	–	–	–	–	·009	24,000*	18,081*	1·98	2·00	7·9200	·051	·001	–	–	–	–	·105	10,000*	6,313*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1335	Temp. 56°.		3	7·283	1·3	·002	·005	·007	·009	–	–	–	·011	32,000	24,108	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·2	·1	2·1	–	–	–	–	–	–	–	–	–	3°·5
1336	FRACTURE.		1	7·139	1·3	·001	·004	·005	·007	·010	–	–	·012	36,000	27,122	1·98	2·04	8·2399	·048	·000	·114	·010	–	–	·122	10,100	6,128	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1337	Light Grey. Dull.	Vertical. Gradual	2	6·876	1·297	·002	·005	·008	·010	–	–	–	·012	34,000*	25,734*	2·04	2·06	8·6569	·053	·001	–	–	–	–	·120	10,000*	5,775*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1338	Regular. Fine Grain.		3	7·270	1·3	·002	·005	·008	·010	–	–	–	·012	33,500	25,239	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·6	·2	2·4	–	–	–	–	–	–	–	–	–	4°·7
1339			1	7·009	1·3	·000	·001	·002	·005	·006	·007	–	·010	42,100	31,717	2·00	2·01	8·0802	·048	·003	–	–	–	–	·136	10,000	6,187	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1340	Tolerable working qualities.	Vertical. Quick	2	7·198	1·3	·001	·003	·005	·007	·009	–	–	·010	36,100	27,197	1·99	2·00	7·9600	·050	·002	·111	·007	–	–	·144	11,600	7,286	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1341			3	7·160	1·3	·001	·004	·005	·007	–	–	–	·009	39,400	29,683	–	–	–	–	–	–	–	–	–	–	–	–	1·799	–	–	–	–	–	–	–	–	–	–	–	–	3°·7
	GENERAL MEAN			7·143	1·3	·002	·004	·006	·008	·009	–	–	·011	36,728*	27,676*	2·00	2·00	8·0000	·049	·001	·108	·008	–	–	·153	12,375*	7,793*	1·798	2·3	·1	2·2	5·9	2·2	3·7	–	–	–	–	–	–	6°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 33, at the end.

OLD HILL FURNACES, NEAR DUDLEY.

FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·55
Carbon, combined	0·25
Silicon	1·36
Sulphur	0·11
Phosphorus	0·41
Manganese	0·54

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·230	27,875	8,731	7,410	116,713	12·444	3·897	3·308	52·104
1,720	7,410	36°	1·20	1·3	·6	2·16	·018	·003	·015	·031	·011	·020	·051	·025	·026	·086	·052	·034	-	-	-	33,000	116,713									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·180	29,934	9,673*	7,315	110,700	13·363	4·318*	3·265	49·419
1,700	7,315	39°	2·90	1·3	·6	2·16	·019	·005	·014	·038	·018	·020	·065	·037	·028	·121	·087	·034	-	-	-	31,300	110,700									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·205	29,582	9,212	6,011	- -	13·206	4·112	2·683	—
1,400	6,011	35°	1·58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·027	23,103*	6,454*	5,066*	129,799	10·312*	2·881*	2·261*	57·945
1,180*	5,066*	36°	1·83	1·3	·6	2·16	·018	·001	·017	·030	·008	·022	·045	·018	·027	·068	·041	·027	·109	·067	·042	30,700	129,799									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·095	26,031*	5,951*	5,161*	122,018	11·620*	2·656*	2·304*	54·472
1,200*	5,161*	40°	1·73	1·3	·6	2·16	·017	·003	·014	·030	·010	·020	·049	·020	·029	·070	·035	·035	-	-	-	34,500	122,018									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·122	29,532	6,736	4,207*	- -	13·183	3·007	1·878*	—
980*	4,207*	25°	1·25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,363*	5,861*	35°	1·75	1·3	·6	2·16	·018	·003	·015	·032	·012	·020	·052	·025	·027	·086	·054	·032	·109	·067	·042	33,875	119,807	7·143	27,676*	7,793*	5,861*	119,807	12 355*	3·479*	2·616*	53·494
Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - -																								7·205	29,130	9,205*	6,912	113,707	13·044	4·109*	3·085	50·762
																								Vertical - - - -		7·081	26,222*	6,380*	4,811*	125,909	11·706*	2·848*	2·147*	56·209
																								Horizontally and Vertically cast - - - Slow - - - - -		7·129	25,489*	7,592*	6,238*	123,256	11·379*	3·389*	2·784*	55·022
																								Gradual - - - -		7·138	27,982*	7,812*	6,238*	116,359	12·491*	3·487*	2·784*	51·945
																								Quick - - - - -		7·164	29,557	7,974	5,109*	- -	13·195	3·559	2·280*	—
																								Ratio in terms of the Crushing Force - - -							·231	·065	·049	1·000

OLD HILL FURNACE, DUDLEY.

(Messrs. Badger & Company.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores.

The ores employed are whitestone, gubbin, grains, pins, balls, and poor robins, with a small portion of red ore from Ulverston.

I. *Whitestone, West Bromwich.*—An average was taken from the two samples of clay ironstone received under this name. They were brownish-grey in colour; homogeneous; and minutely crystalline in structure. One was very irregular in shape, the other occurring as a more definite seam of about 2½ inches in thickness.

II. *Gubbin, Bell Farm.*—Clay ironstone, pale blackish-grey; structure, minutely crystalline; having but very few and thin seams of limespar. The sample appears to have been derived from a five-inch seam.

III. *Grains, Bell Farm.*—Blackish-grey clay ironstone, intersected by numerous veins of limespar. The sample measures five inches in depth.

IV. *Balls, Bilston.*—A nodular form of clay ironstone, pale greyish-brown in colour; distinctly crystalline in structure; and having numerous internal cavities partly filled with a pulverulent form of silicate of alumina, in which crystals of zinc blende occur.

	I. Whitestone.	II. Gubbin.	III. Grains.	IV. Balls.
Protoxide of iron	43·33	52·50	48·96	48·00
Protoxide of manganese	0·60	1·00	1·06	0·57
Lime	4·53	1·06	3·73	1·10
Magnesia	2·66	0·58	0·84	1·21
Carbonic acid	32·64	33·47	33·60	30·70
Phosphoric acid	0·78	0·75	0·72	1·07
Bisulphide of iron	0·16	*trace*	*trace*	0·18
Water hygroscopic	0·28	0·26	0·30	0·37
Water, combined	1·36	1·34	1·28	1·15
Organic matter	0·30	0·25	0·35	0·30
Clay, ignited	13·21	8·70	9·40	15·70
	99·85	99·91	100·24	100·35
Metallic iron	34·00	41·02	38·32	37·70

OLD HILL FURNACE, DUDLEY—*continued.*

FUEL.

Coke from the "thick coal" of Old Hill Colliery.

The average of a large sample of coke was found to contain—

Sulphur - - - - - - - - 0·51 per cent.

and to leave on burning,

Ash - - - - - - - - - 4·83 per cent.

The ash consisting of *silicate of alumina*, with *peroxide of iron*, and a little *lime*.

FLUX.

Limestone from Springfield Mine.—Light coloured, crystalline; having a small vein of quartz running through the sample.

(Dried at 212° Fahrenheit.)

Carbonate of lime - - - - -	88·85
Carbonate of magnesia - - - -	2·03
Carbonate of iron - - - - -	1·21
Carbonate of manganese, Organic matter - - - - -	*traces.*
Phosphate of lime (containing of phosphoric acid 0·12) - - - - - -	0·26
Silicious matter (quartz, with a little clay) -	8·15
	100·50

IRONS.

Important Constituents in 100 *Parts.*

	I. No. 2. Pig Iron.	II. No. 3. Pig Iron.	III. No. 4. Pig Iron.	IV. No. 5. Pig Iron.
Carbon, as graphite - - -	3·06	2·69	2·76	2·55
Carbon, combined - - -	- - -	- - -	- - -	0·25
Silicon - - - - -	3·48	2·24	1·75	1·36
Sulphur - - - - -	0·03	0·04	0·07	0·11
Phosphorus - - - -	0·38	0·63	0·55	0·41
Manganese - - - -	0·30	0·34	*trace*	0·54

MESSRS. FIRMSTONE, LAYS

HÆMATITE IRON,

MANUFACTURE.

Pig Iron manufactured from the following Ingredients, viz.:—

	Cwt.
Ulverstone hæmatite	25
Forest of Dean ditto	5
Hydrate of iron	25
Gubbin ironstone, calcined	10
Bottom whitestone, ditto	5

Equal proportions of Froghall and Dudley limestone were used as flux, and equal proportions of Durham, Derbyshire, and Thickbone coke, as fuel.

Cast — 10 October 1856.

Barometer — 30·17

Thermometer — 64·

CASTING.

Weight of—	*cwt.*	*qrs.*	*lbs.*
Charge	5	0	0
Castings	3	2	19
Runners	0	1	25
Slag and Waste	2	0	16
Coals consumed	4	2	13

Time of—	*hrs.*	*min.*
Melting	0	45
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1738			1	7·240	1·3	·001	·003	·005	·007	·009	·011	–	·012	42,100	31,717
1739	Mark $\frac{16}{1}$.	Horizontal. Slow	2	7·255	1·3	·000	·001	·004	·006	·010	·013	–	·013	40,000	30,135
1740	CAST.		3	7·282	1·3	·003	·006	·008	·009	·011	·015	–	·016	41,300	31,115
1741	9 October 1856.		1	7·259	1·3	·001	·004	·006	·007	·008	·012	–	·014	41,400	31,190
1742	TESTED.	Gradual	2	7·261	1·3	·000	·001	·003	·005	·007	·010	–	·013	42,800	32,245
1743	Tensile, 28 Jan. 1858. Temp. 53°.		3	7·266	1·3	·000	·001	·003	·005	·007	·009	–	·009	40,000	30,135
1744			1	7·260	1·3	·001	·003	·005	·006	·008	·009	–	·011	43,800	32,998
1745	Transverse, 28 Oct. 1857. Temp. 59°.	Quick	2	7·260	1·3	·001	·004	·007	·009	·012	·016	–	·018	43,600	32,847
1746	Torsion, 23 Nov. 1857. Temp. 58°.		3	7·271	1·3	·000	·001	·002	·003	·004	·005	–	·006	44,100	33,224
1747			1	7·235	1·3	·000	·001	·003	·005	·007	·009	–	·010	41,300	31,115
1748	Crushing, 31 Jan. 1859. Temp. 56°.	Vertical. Slow	2	7·248	1·3	·002	·005	·006	·008	·010	·011	–	·013	41,500	31,266
1749			3	7·232	1·3	·002	·005	·008	·010	·012	·013	–	·014	41,100	30,964
1750	FRACTURE. Medium Grey.		1	7·232	1·3	·002	·005	·007	·009	·012	·015	–	·018	42,500	32,019
1751	Dull.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1752	Regular. Fine Grain.		3	7·245	1·3	·000	·002	·003	·005	·006	–	–	·009	39,500*	29,759*
1753	Good working qualities.		1	–	–	–	–	–	–	–	–	–	–	–	–
1754		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1755			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			7·253	1·3	·001	·003	·005	·006	·008	·011	–	·012	41,785*	31,480*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1738	2·07	2·00	8·2800	·056	·007	·115	·015	–	–	·175	13,500	8,152
1739	2·07	2·00	8·2800	·057	·005	·119	·015	–	–	·184	13,700	8,272
1740	–	–	–	–	–	–	–	–	–	–	–	–
1741	2·03	1·97	7·8782	·053	·003	·114	·013	–	–	·126	10,500*	6,663*
1742	2·04	1·98	7·9976	·053	·002	·113	·011	–	–	·150	12,100*	7,564*
1743	–	–	–	–	–	–	–	–	–	–	–	–
1744	2·03	2·00	8·1200	·050	·001	·105	·010	·165	·015	·210	17,900	11,022
1745	2·03	1·94	7·6401	·055	·005	·110	·010	·179	·021	·239	17,300	11,321
1746	–	–	–	–	–	–	–	–	–	–	–	–
1747	2·02	2·07	8·6554	·055	·005	·115	·016	–	–	·170	13,600	7,856
1748	2·01	2·03	8·2830	·054	·003	·117	·015	–	–	·180	11,900	7,183
1749	–	–	–	–	–	–	–	–	–	–	–	–
1750	2·01	2·04	8·3648	·053	·004	·114	·015	–	–	·150	12,500	7,471
1751	–	–	–	–	–	–	–	–	–	–	–	–
1752	–	–	–	–	–	–	–	–	–	–	–	–
1753	2·03	2·06	8·6145	·057	·004	·120	·012	–	–	·133	10,200*	5,920*
1754	–	–	–	–	–	–	–	–	–	–	–	–
1755	–	–	–	–	–	–	–	–	–	–	–	–
	2·03	2·01	8·2014	·054	·004	·114	·013	·172	·018	·171	13,320*	8,142*

Register No.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1738	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1739	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1740	1·799	3·	·9	2·1	–	–	–	–	–	–	–	–	–	6°·3
1741	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1742	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1743	1·798	2·9	·6	2·3	–	–	–	–	–	–	–	–	–	5°·8
1744	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1745	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1746	1·798	2·1	·0	2·1	4·	1·	3·	–	–	–	–	–	–	7°·
1747	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1748	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1749	1·797	2·2	·1	2·1	–	–	–	–	–	–	–	–	–	4°·2
1750	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1751	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1752	1·795	2·6	·2	2·4	–	–	–	–	–	–	–	–	–	4°·
1753	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1754	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1755	1·798	–	–	–	–	–	–	–	–	–	–	–	–	3°·2
	1·797	2·5	·3	2·2	4·	1·	3·	–	–	–	–	–	–	5°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 34, at the end.

IRON WORKS, NEAR DUDLEY.

(FIRST MELTING).

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·15
Silicon	1·05
Sulphur	0·05
Phosphorus	0·29
Manganese	1·14

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of												Breaking Weight.											
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·259	30,989	8,212	5,367*	115,652	13·834	3·666	2·395*	51·630
1,250*	5,367*	40°	1·80	1·3	·6	2·16	·020	·006	·014	·040	·017	·023	·065	·036	·029	·111	·078	·033	-	-	-	32,700	115,652									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·262	31,190	7,113*	4,516*	119,896	13·924	3·175*	2·016*	53·525
1,050*	4,516*	50°	1·70	1·3	·6	2·16	·019	·007	·012	·040	·018	·022	·065	·035	·030	·104	·068	·036	-	-	-	33,900	119,896									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·263	33,023	11,171	6,623*	124,494	14·742	4·987	2·956*	55·577
1,540*	6,623*	36°	1·82	1·3	·6	2·16	·017	·006	·011	·037	·014	·023	·055	·026	·029	·093	·050	·043	·173	·123	·050	35,200	124,494									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·238	31,115	7,519	5,212*	118,481	13·890	3·356	2·326*	52·893
1,210*	5,212*	38°	1·80	1·3	·6	2·16	·022	·009	·013	043	·020	·023	·067	·038	·029	·111	·076	·035	-	-	-	33,500	118,481									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·238	30,592*	7,471	4,841*	- -	13·657*	3·335	2·161*	—
1,120*	4,841*	36°	1·70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,920*	3,870*	- -	- -	- -	2·642*	1·727*	—
900*	3,870*	25°	1·23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,178*	5,071*	37°	1·67	1·3	·6	2·16	·019	·007	·012	·040	·017	·023	·063	·034	·029	·105	·068	·037	·173	·123	·050	33,825	119,631	7·253	31,480*	8,142*	5,071*	119,631	14·053*	3·634*	2·263*	53·406
																								7·261	31,734	8,832*	5,502*	120,014	14·166	3·942*	2·456*	53·577
Combined Means - - - Slow, Gradual, and Quick cooling - - Horizontal - - -																								7·238	31,024*	7,107*	4,641*	118,481	13·850*	3·172*	2·071*	52·893
Horizontally and Vertically cast - - Slow - - - - -																								7·249	31,052	7,865	5,289*	117,067	13·862	3·511	2·361*	52·262
Gradual - - - -																								7·250	30,891*	7,792*	4,678*	119,896	13·790*	3·478*	2·088*	53·525
Quick - - - -																								7·238	33,023	8,545*	5,246*	124,494	14·742	3·814*	2·341*	55·577
																								Ratio in terms of the Crushing Force - - -					·263	·068	·042	1·000

LAYS IRON WORKS, NEAR DUDLEY.

(Messrs. Firmstone & Co.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores and Fluxes.

No samples of raw materials were received from the works, but the following were stated to be the ores employed in the production of the specimen of iron forwarded :—

Ores.	Proportion.
	Cwt.
Ulverston hæmatite	25
Forest of Dean hæmatite	5
"Hydrate of iron"	25
Gubbin ironstone (calcined)	10
Bottom whitestone (calcined)	5
	70

Among the ores enumerated, complete analyses have already been made of the raw gubbin and bottom whitestone from Netherton, and of the same ores, roasted, from the Park Head Furnaces. The Ulverston and Forest of Dean ores, and the Froghall and Dudley limestones, the latter employed as fluxes in the proportion of equal parts, have also been fully described.

A characteristic sample, from Dudley, of the *Bottom whitestone,* in which fossil shells were contained, had the following composition :—

Protoxide of iron	48·63
Protoxide of manganese	1·29
Lime	4·45
Magnesia	0·80
Carbonic acid	32·16
Phosphoric acid	0·82
Bisulphide of iron	0·16
Water, hygroscopic	0·32
Water, combined	1·23
Organic matter	0·28
Clay, ignited	10·30
	100·44
The clay contained of—	
Silica	6·21
Alumina	3·64
Peroxide of iron	0·04
Lime, Magnesia	*traces.*
Potash	0·11
	10·00
Metallic iron	37·85

LAYS IRON WORKS, NEAR DUDLEY—*continued.*

FUEL.

Durham, Derbyshire and "Thickbone" cokes are stated to be employed in the proportion of equal parts.

IRON.

Specified as "Pig Iron, first melting."

Important Constituents in 100 *Parts.*

Carbon, as graphite	3·15
Silicon	1·05
Sulphur	0·05
Phosphorus	0·29
Manganese	1·14

Remarks.—Analyses of several other samples of iron, representing supplies from these works, are included in the Appendix.

LORD WARD, LEVEL IRON

HOT BLAST

MANUFACTURE.

Pig iron direct from the hot blast furnaces manufactured from the following ingredients,—

	cwt.
Gubbin ironstone	30
White ironstone	30
Limestone	11
Thick coal coke	29

The above proportions produce one ton of pig iron as per sample.

CASTING.

Cast — 20 October 1856.

Barometer — 30·23

Thermometer — 64°

Weight of—	*cwt.*	*qrs.*	*lbs.*
Charge	5	0	0
Castings	3	3	18
Runners	0	1	19
Slag and waste	1	1	3
Coals consumed	4	2	12

Time of—	*hrs.*	*min.*
Melting	0	47
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1558			1	7·174	1·3	·001	·005	·008	·010	–	–	–	·015	32,500	24,485
1559	Mark $\frac{12}{1}$.	Slow	2	7·136	1·3	·003	·008	·010	·012	–	–	–	·016	32,300	24,334
1560			3	7·148	1·3	·002	·006	·008	·010	–	–	–	·012	34,800	26,218
	CAST.														
1561	20 October 1856.		1	7·182	1·3	·002	·005	·007	·008	·012	–	–	·014	36,300	27,348
1562		Gradual	2	7·157	1·3	·002	·006	·010	·013	·016	–	–	·019	37,800	28,478
1563	TESTED.		3	7·183	1·3	·001	·004	·006	·007	·008	–	–	·012	35,300	26,594
	Tensile, 12 Oct. 1857.														
1564	Temp. 63°.		1	7·150	1·3	·002	·004	·006	·007	–	–	–	·012	34,000	25,615
1565	Transverse, 22 Aug. 1857.	Quick	2	7·178	1·3	·002	·005	·007	·008	·010	–	–	·011	38,900	29,306
1566	Temp. 70°.		3	7·185	1·3	·002	·005	·007	·010	·012	–	–	·015	37,700	28,402
	Torsion, 17 Oct. 1857.														
1567	Temp. 63°.		1	7·127	1·3	·003	·005	·008	·009	·013	–	–	·013	35,000	26,368
1568		Slow	2	–	–	–	–	–	–	–	–	–	–	–	–
1569	Crushing, 1 Feb. 1859.		3	7·082	1·3	·000	·003	·004	·006	–	–	–	·009	33,500	25,239
	Temp. 54°.														
1570			1	7·091	1·3	·002	·005	·008	·009	–	–	–	·013	31,100	23,430
	FRACTURE.	Vertical.													
1571	Medium Grey.	Gradual	2	7·106	1·3	·001	·004	·006	·008	–	–	–	·011	31,000	23,355
1572	Dull.		3	7·114	1·3	·000	·002	·004	·005	–	–	–	·011	32,000	24,108
	Regular.														
1573	Fine Grain.		1	7·145	1·3	·001	·004	·007	·009	·012	–	–	·013	37,100	27,950
1574	Good working quality.	Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1575			3	7·137	1·3	·001	·003	·005	·007	·008	–	–	·011	37,100	27,950
	GENERAL MEAN			7·143	1·3	·001	·005	·007	·009	·011	–	–	·013	34,775	26,198

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1558	2·06	1·99	8·1578	·054	·001	·115	·010	–	–	·145	11,500	7,048	–	–	–	–	–	–	–	–	–	–	–	–	–
1559	2·04	1·91	7·4421	·066	·007	·135	·020	–	–	·172	11,900	7,995	–	–	–	–	–	–	–	–	–	–	–	–	–
1560	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·7	·3	2·4	7·	3·7	3·3	–	–	–	–	–	–	9°·5
1561	2·00	1·98	7·8408	·053	·002	·113	·008	–	–	·160	12,900	8,226	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1562	2·04	2·02	8·3240	·054	·004	·118	·014	–	–	·171	13,500	8,109	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1563	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·7	·1	2·6	–	–	–	–	–	–	–	–	–	3°·4
1564	2·03	1·98	7·9584	·056	·002	·116	·012	–	–	·154	13,000	8,167	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1565	2·01	2 01	8·1206	·057	·002	·118	·013	–	–	·176	13,800	8,496	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1566	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·	·0	2·	–	–	–	–	–	–	–	–	–	2°·
1567	1·98	2·02	8·0791	·055	·002	–	–	–	–	·115	9,000*	5,569*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1568	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1569	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·	·0	2·	–	–	–	–	–	–	–	–	–	4°·1
1570	1·98	2·01	7·9993	·055	·002	–	–	–	–	·113	9,500	5,937	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1571	1·97	2·01	7·9589	·055	·002	·121	·014	–	–	·130	10,100	6,345	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1572	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·2	·1	2·1	6·8	3·3	3·5	–	–	–	–	–	–	6°·8
1573	1·97	2·02	8·0383	·055	·003	·115	·010	–	–	·123	10,700*	6,655*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1574	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1575	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·1	·0	2·1	5·4	1·	4·4	–	–	–	–	–	–	8°·5
	2·01	1·99	7·9598	·056	·003	·119	·013	–	–	·145	11,590*	7,254*	1·797	2·3	·1	2·2	6·4	2·6	3·8	–	–	–	–	–	–	5°·7

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 35, at the end.

WORKS, BRIERLEY HILL.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·61
Silicon	1·40
Sulphur	0·04
Phosphorus	0·72
Manganese	0·49

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,610	6,936	36°	1·90	1·3	·6	2·16	·015	·003	·012	·036	·015	·021	·069	·040	·029	-	-	-	-	-	-	28,400	100,444	7·152	25,012	7,521	6,936	100,444	11·166	3·357	3·096	44·841
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,100*	4,790*	35°	1·72	1·3	·6	2·16	·018	·005	·013	·040	·020	·020	·076	·049	·027	-	-	-	-	-	-	29,500	104,334	7·174	27,473	8,167	4,790*	104,334	12·264	3·645	2·138*	46·577
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
850*	3,655*	27°	1·50	1·3	·6	2·16	·019	·005	·014	·040	·019	·021	·071	·044	·027	-	-	-	-	-	-	29,600	104,688	7·171	27,774	8,331	3,655*	104,688	12·399	3·719	1·631*	46·732
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,250*	5,376*	40°	1·95	1·3	·6	2·16	·015	·001	·014	·045	·022	·023	-	-	-	-	-	-	-	-	-	24,500	86,650	7·104	25,803	5,569*	5,376*	86,650	11·519	2·486*	2·400*	38·683
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,500	6,462	37°	2·28	1·3	·6	2·16	·019	·009	·010	·045	·025	·020	·089	·061	·028	-	-	-	-	-	-	26,200	92,663	7·103	23,631	6,141	6,462	92,663	10·549	2·741	2 884	41·367
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,870	8,056	39°	2·10	1·3	·6	2·16	·016	·003	·013	·034	·012	·022	·058	·030	·028	·109	·075	·034	-	-	-	31,100	109,993	7·141	27,950	6,655*	8,056	109,993	12·477	2·970*	3·596	49·102
1,361*	5,879*	35°	1·91	1·3	·6	2·16	·017	·004	·013	·040	·019	·021	·073	·045	·028	·109	·075	·034	-	-	-	28,217	99,795	7·143	26,198	7,254*	5,879*	99,795	11·695	3·238*	2·624*	44·551
Combined Means - - -																					Slow, Gradual and Quick cooling - -	Horizontal - - -	7·166	26,753	8,006	5,127*	103,155	11·943	3·574	2·288*	46·051
																					Vertical - - - -	7·114	25,485	6,126*	6,631*	96,435	11·377	2·734*	2·960*	43·051
																					Horizontally and Vertically cast - - -	Slow - - - - -	7·128	25,407	6,545*	6,156*	93,547	11·342	2·921*	2·748*	41·687
																						Gradual - - - -	7·139	25,552	7,154	5,626*	98,499	11·407	3 193	2·511*	43·972
																						Quick - - - -	7·156	27,862	7,493*	5,855*	107,341	12·438	3·345*	2·613*	47·919
																												Ratio in Terms of the Crushing Force - - -				·262	·072	·058	1·000

LORD WARD, LEVEL IRON

COLD BLAST

MANUFACTURE.

Pig Iron direct from the cold blast furnace, charged with the following ingredients; viz.—

	cwt.
Gubbin ironstone	30
White ironstone	30
Limestone	13
Thick coal coke	36

CASTING.

Cast	6 October 1856.
Barometer	29·99
Thermometer	67·

Weight of—	cwt.	qrs.	lbs.
Charge	4	3	22
Castings	3	3	7
Runners	0	2	6
Slag and waste	1	2	10
Coals consumed	3	2	20

Time of—	hrs.	min.
Melting	1	0
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1576	Mark $\frac{12}{2}$. CAST. 6 October 1856. TESTED. Tensile, 13 Oct. 1857. Temp. 63°. Transverse, 22 Aug. 1857. Temp. 70°. Torsion, 20 Oct. 1857. Temp. 61°. Crushing, 1 Feb. 1859. Temp. 54°. FRACTURE. Light Grey. Dull. Regular. Fine Grain. Good working qualities.	Horizontal. Slow	1	7·155	1·3	·000	·003	·005	·007	–	–	–	·012	34,500	25,992	2·01	1·99	7·9598	·056	·005	·116	·012	–	–	·165	13,000	8,166	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1577			2	7·133	1·3	·001	·005	·009	·011	·014	–	–	·017	35,000	26,368	2·02	1·93	7·5242	·056	·002	·125	·011	–	–	·196	13,200	8,771	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1578			3	7·146	1·3	·001	·005	·006	·008	·011	–	–	·014	35,900	27,046	–	–	–	–	–	–	–	–	–	–	–	–	1·8	2·	·0	2·	6·2	2·4	3·8	–	–	–	–	–	–	12°·3
1579		Horizontal. Gradual	1	7·118	1·3	·002	·004	·007	·009	·013	–	–	·013	35,000	26,368	2·01	1·97	7·8006	·060	·005	·130	·015	–	–	·166	12,300	7,884	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1580			2	7·123	1·3	·001	·004	·007	·009	·012	–	–	·012	35,000	26,368	2·00	1·95	7·6050	·060	·003	·129	·011	–	–	·162	11,800	7,758	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1581			3	7·153	1·3	·002	·004	·007	·009	–	–	–	·013	34,500	25,992	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·6	·1	2·5	–	–	–	–	–	–	–	–	–	3°·7
1582		Quick	1	7·095	1·3	·002	·005	·007	·010	–	–	–	·014	34,500	25,992	2·06	1·98	8·0760	·054	·003	·120	·011	–	–	·135	11,000	6,810	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1583			2	7·123	1·3	·002	·005	·007	·010	–	–	–	·012	34,500	25,992	2·04	2·04	8·4896	·054	·002	·116	·011	–	–	·148	11,500	6,772	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1584			3	6·291*	1·3	·003	·006	·009	·011	–	–	–	·016	33,500	25,239	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·2	·5	2·7	–	–	–	–	–	–	–	–	–	4°·3
1585		Vertical. Slow	1	7·068	1·3	·002	·005	·008	·011	–	–	–	·014	33,200	25,013	1·97	1·99	7·8013	·056	·005	–	–	–	–	·120	9,500	6,088	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1586			2	7·079	1·3	·002	·005	·008	·010	–	–	–	·013	32,900	24,786	1·98	1·98	7·7623	·060	·005	–	–	–	–	·110	8,500	5,475	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1587			3	7·073	1·3	·003	·006	·008	·010	–	–	–	·014	34,100	25,690	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·2	·0	2·2	7·3	3·	4·3	–	–	–	–	–	–	9°·2
1588		Gradual	1	7·055	1·3	·001	·004	·007	·009	–	–	–	·013	34,900	26,293	1·96	1·96	7·5295	·056	·005	–	–	–	–	·130	10,000	6,640	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1589			2	7·035	1·3	·001	·004	·007	·008	–	–	–	·012	34,800	26,218	1·97	1·97	7·6453	·060	·004	–	–	–	–	·105	8,500	5,558	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1590			3	7·093	1·3	·002	·004	·007	·009	–	–	–	·013	34,600	26,067	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·9	·2	2·7	–	–	–	–	–	–	–	–	–	5°·8
1591		Quick	1	7·073	1·3	·001	·003	·005	·007	–	–	–	·009	32,000	24,108	1·97	1·98	7·7231	·059	·003	–	–	–	–	·120	9,300*	6,020*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1592			2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1593			3	7·069	1·3	·001	·003	·005	·006	–	–	–	·012	34,900	26,293	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·	·0	2·	–	–	–	–	–	–	–	–	–	2°·
	GENERAL MEAN			7·052*	1·3	·001	·004	·007	·009	·012	–	–	·013	34,341	25,872	2·00	1·97	7·7618	·057	·004	·123	·012	–	–	·129	10,782*	6,903*	1·798	2·4	·1	2·3	6·7	2·7	4·	–	–	–	–	–	–	6°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 36, at the end.

WORKS, BRIERLEY HILL.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·56
Silicon	1·75
Sulphur	0·05
Phosphorus	0·63
Manganese	0·06

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,780	7,630	37°	2·30	1·3	·6	2·16	·020	·006	·014	·045	·024	·021	·095	·065	·030	–	–	–	–	–	–	26,800	94,785	7·144	26,468	8,468	7,630	94,785	11·816	3·780	3·406	42·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,100*	4,739*	30°	1·87	1·3	·6	2·16	·021	·010	·011	·046	·028	·018	·105	·078	·027	–	–	–	–	–	–	26,500	93,724	7·131	26,242	7,821	4,739*	93,724	11·715	3·491	2·115*	41·841
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,010*	4,336*	–	–	1·3	·6	2·16	·021	·008	·013	·048	·028	·020	·105	·075	·030	–	–	–	–	–	–	26,600	94,078	6·836	25,741	6,791	4,336*	94,078	11·491	3·031	1·935*	41·999
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,590	6,838	35°	2·10	1·3	·6	2·16	·021	·008	·013	0·47	·025	·022	·100	·071	·029	–	–	–	–	–	–	26,000	91,955	7·073	25,163	5,781	6,838	91,955	11·233	2·580	3·052	41·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,400	6,031	38°	1·70	1·3	·6	2·16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14,000 *	49,514 *	7·061	26,192	6,099	6,031	49,514 *	11·692	2·722	2·692	22·104*
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,010*	4,351*	35°	1·48	1·3	·6	2·16	·020	·005	·015	·045	·024	·021	·089	·059	·030	–	–	–	–	–	–	27,100	95,846	7·071	25,200	6,020*	4,351*	95,846	11·250	2·687*	1·942*	42·788
1,315*	5,654*	36°	1·89	1·3	·6	2·16	·021	·007	·014	·046	·026	·020	·099	·070	·029	–	–	–	–	–	–	24,500*	86,650*	7·052*	25,872	6,903*	5,654*	86,650 *	11·550	3·081*	2·524*	38·683 *
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·037*	26,150	7,693	5,568*	94,196	11·674	3·434	2·485*	42·051
Vertical - - -																								7·068	25,558	5,956*	5,740*	79,105 *	11·409	2·658*	2·562*	35·314 *
Horizontally and Vertically cast - - - Slow - - -																								7·109	25,815	7,124	7,234	93,370	11·524	3·180	3·229	41·683
Gradual - - -																								7·096	26,217	6,960	5,385*	71,619 *	11·704	3·107	2·404*	31·972 *
Quick - - -																								6·954*	25,470	6,405*	4,343*	94,962	11·370	2·859*	1·938*	42·393
Ratio in terms of the Crushing Force - - -																													·298	·079	·068	1·000

LEVEL IRON WORKS, BRIERLEY HILL.

(Lord Ward.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores.

Gubbin and white ironstone, employed in equal proportions, without previous roasting.

Gubbin.—A clay ironstone, dark slatey-grey in colour, with numerous veins of limespar, in which are contained shells and other fossil remains.

An average sample of the ore contained:—

Metallic iron	41·67	per cent.
equivalent to		
Protoxide of iron	53·58	„
Phosphoric acid	0·83	„
Clay (ignited)	4·80	„

No appreciable amount of sulphur was found in the ore.

White Ironstone.—A clay-iron ore, light-brownish grey in colour, and homogeneous, with exception of darker coloured flaws or cracks, where the ore was slightly peroxidised.

An average sample was found to contain of:—

Metallic iron	37·93	per cent.
equivalent to		
Protoxide of iron	48·77	„
Phosphoric acid	1·18	„
Clay (ignited)	9·30	„

A trace only of sulphur was contained in the ore.

Fuel.

The "*Thick Coal*," from which the coke used at the works is prepared, contained—

Sulphur - - - - - - - - 0·87 per cent.

and left on burning,

Ash - - - - - - - - 3·40 per cent.

The red ash consisted of burnt shale, *silicate of alumina*, with *peroxide of iron*, and traces only of *lime* and *magnesia*.

Coke, made from the "*Thick Coal*."

An average sample contained—

Sulphur - - - - - - - - 0·50 per cent.

and left, on burning,

Ash - - - - - - - - 2·66 per cent.

LEVEL IRON WORKS, BRIERLEY HILL—*continued.*

FLUX.

Limestone, light coloured, crystalline, and resembling in all its physical characters the sample received from the Park Head Furnaces (series 9). It was found on analysis to contain nearly the same amount of *carbonate of magnesia*, or 0·70 per cent.

IRONS.

Important Constituents in 100 *parts.*

	I. Hot Blast Pig Iron.	II. Cold Blast Pig Iron.
Carbon, as graphite - - - -	2·61	2·56
Silicon - - - - - -	1·40	1·75
Sulphur - - - - - -	0·04	0·05
Phosphorus - - - - - -	0·72	0·63
Manganese - - - - - -	0·49	0·06

The chemical analyses were made upon the square bars cast for subjection to mechanical tests. I. represents the average of four pigs of hot-blast iron; and II., that of five cold-blast pigs, which had been received from the works.

Remarks.—Complete analyses of ores from the neighbouring district of Dudley, similar to those used at these works, will be found on reference to the Reports on the samples from the Netherton and Old Hill Works.

MESSRS. BUTLIN AND CO., EAST END

No. 1.—GREY FOUNDRY

MANUFACTURE.

Grey Foundry Iron, first running from the furnace;
The fluxes employed consist of an argillaceous limestone and a portion of chalk; smelted by cold blast from Barnsley coal.
The following ingredients produce one ton of iron (No. 1):—

	Tons. cwt.
Ore (not calcined)	2 18
Barnsley coal	2 16
Argillaceous limestone	0 10
Chalk	0 2

Cast	2 October 1856.
Barometer	29·80
Thermometer	67·

CASTING.

Weight of—	*cwt. qrs. lbs.*
Charge	5 0 0
Castings	4 0 17
Runners	0 2 7
Slag and waste	0 2 6
Coals consumed	3 3 0

Time of—	*hrs. min.*
Melting	0 53
Remaining in the moulds for the three modes of cooling—	
Slow	24 0
Gradual	4 0
Quick	0 30
Tapping after melting	0 15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1414	Mark $\frac{9}{1}$.	Horizontal. Slow	1	7·185	1·3	·003	·005	·009	–	–	–	–	·010	29,000	21,845
1415			2	7·192	1·3	·002	·004	·007	–	–	–	–	·008	28,000	21,095
1416			3	7·196	1·3	·001	·003	·006	–	–	–	–	·008	28,800	21,698
1417	CAST. 2 October 1856.	Horizontal. Gradual	1	7·193	1·3	·003	·004	·005	–	–	–	–	·010	29,400	22,149
1418			2	7·178	1·3	·004	·007	·010	–	–	–	–	·011	26,000	19,588
1419	TESTED.		3	7·217	1·3	·002	·005	·007	–	–	–	–	·009	27,900	21,019
1420	Tensile, 2 Oct. 1857. Temp. 62°.	Horizontal. Quick	1	7·197	1·3	·001	·004	·006	–	–	–	–	·007	29,300	22,074
1421			2	7·180	1·3	·002	·004	·006	–	–	–	–	·007	28,000	21,095
1422	Transverse, 3 Aug. 1857. Temp. 79°.		3	7·184	1·3	·002	·005	·007	–	–	–	–	·009	29,900	22,526
1423	Torsion, 13 Aug. 1857. Temp. 70°.	Vertical. Slow	1	7·179	1·3	·002	·004	–	–	–	–	–	·007	24,800	18,684
1424			2	–	–	–	–	–	–	–	–	–	–	–	–
1425	Crushing, 1 Feb. 1859. Temp. 54°.		3	7·173	1·3	·002	·004	·006	–	–	–	–	·010	25,900	19,512
1426		Vertical. Gradual	1	7·176	1·3	·002	·005	–	–	–	–	–	·012	25,500	19,210
1427	FRACTURE. Light Grey. Regular. Fine Grain. Difficult Working.		2	7·187	1·3	·001	·003	·008	–	–	–	–	·008	25,000	18,834
1428			3	7·186	1·3	·000	·002	–	–	–	–	–	·005	21,000	15,821
1429		Vertical. Quick	1	7·189	1·3	·002	·005	–	–	–	–	–	·011	22,000	16,574
1430			2	–	–	–	–	–	–	–	–	–	–	–	–
1431			3	7·148	1·3	·000	·001	·002	–	–	–	–	·003	26,500	19,964
	GENERAL MEAN			7·185	1·3	·002	·004	·007	–	–	–	–	·008	26,687	20,105

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1414	2·03	2·01	8·2014	·050	·001	·106	·003	–	–	·125	10,500	6,401	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1415	2·02	2·00	8·0800	·056	·004	·115	·007	–	–	·121	10,500	6,497	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1416	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·3	·1	2·2	–	–	–	–	–	–	–	–	–	3°·
1417	2·06	1·98	8·0760	·054	·005	–	–	–	–	·114	9,900	6,129	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1418	2·03	1·99	8·0390	·053	·005	–	–	–	–	·110	9,000	5,597	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1419	–	–	–	–	–	–	–	–	–	–	–	–	1·8	2·5	·0	2·5	–	–	–	–	–	–	–	–	–	3°·
1420	2·01	1·99	7·9598	·055	·005	·115	·006	–	–	·120	10,700	6,721	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1421	2·00	1·94	7·5272	·055	·002	–	–	–	–	·110	9,500	6,310	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1422	–	–	–	–	–	–	–	–	–	–	–	–	1·796	1·9	·0	1·9	–	–	–	–	–	–	–	–	–	2°·
1423	2·00	2·02	8·1608	·055	·004	–	–	–	–	·082	6,500	3,982	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1424	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1425	–	–	–	–	–	–	–	–	–	–	–	–	1·799	2·	·2	1·8	–	–	–	–	–	–	–	–	–	4°·9
1426	1·93	1·94	7·2637	·059	·003	–	–	–	–	·083	6,900	4,749	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1427	1·97	1·97	7·6453	·058	·005	–	–	–	–	·091	7,500	4,904	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1428	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·1	·0	2·1	–	–	–	–	–	–	–	–	–	3°·8
1429	1·99	2·01	8·0397	·055	·005	–	–	–	–	·114	9,900	6,156	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1430	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1431	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·8	·0	1·8	–	–	–	–	–	–	–	–	–	4°·
	2·00	1·99	7·9202	·055	·004	·112	·005	–	–	·107	9,090	5,744	1·798	2·1	·0	2·1	–	–	–	–	–	–	–	–	–	3°·4

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 37, at the end.

IRON WORKS, WELLINGBORO', NORTHAMPTONSHIRE.

PIG, COLD BLAST.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·85
Silicon	1·02
Sulphur	0·10
Phosphorus	1·19
Manganese	0·24

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200	5,161	38°	1·82	1·3	·6	2·16	·015	·000	·015	·028	·005	·023	·042	·013	·029	·075	·039	·036	–	–	–	30,100	106,456	7·191	21,547	6,449	5,161	106,456	9·619	2·879	2·304	47·525
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,150*	4,929*	40°	2·25	1·3	·6	2·16	·014	·001	·013	·027	·006	·021	·043	·017	·026	·077	·043	·034	–	–	–	30,000	106,103	7·196	20,918	5,863	4,929*	106,103	9·338	2·617	2·200*	47·366
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,050	4,531	37°	1·62	1·3	·6	2·16	·015	·001	·014	·026	·005	·021	·041	·015	·026	·077	·041	·036	–	–	–	30,000	106,103	7·187	21,898	6,515	4,531	106,103	9·775	2·908	2·022	47·366
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,460	6,269	40°	1·67	1·3	·6	2·16	·015	·001	·014	·027	·005	·022	·044	·015	·029	–	–	–	–	–	–	29,800	105,395	7·176	19,098	3,982	6,269	105,395	8·525	1·777	2·798	47·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,300	5,591	41°	2·40	1·3	·6	2·16	·015	·006	·009	·032	·014	·018	·052	·025	·027	–	–	–	–	–	–	29,900	105,749	7·183	17,955	4,826	5,591	105,749	8·015	2·154	2·495	47·254
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,410	6,064	36°	2·18	1·3	·6	2·16	·015	·001	·014	·028	·006	·022	·045	·016	·029	–	–	–	–	–	–	29,000	102,566	7·168	18,269	6,156	6,064	102,566	8·155	2·748	2·707	45·788
1,261*	5,424*	38°	1·99	1·3	·6	2·16	·015	·002	·013	·028	·007	·021	·045	·017	·028	·076	·041	·035	–	–	–	29,800	105,395	7·185	20,105	5,744	5,424*	105,395	8·975	2·564	2·421*	47·051
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·191	21,454	6,275	4,873*	106,221	9·577	2·801	2·175*	47·420
Vertical - - - -																								7·176	18,371	4,947	5,974	104,570	8·201	2·208	2·666	46·683
Horizontally and Vertically cast - - - Slow - - - - -																								7·184	20,322	5,215	5,715	105,926	9·072	2·328	2·551	47·288
Gradual - - - -																								7·189	19,436	5,344	5,260*	105,926	8·676	2·385	2·340*	47·288
Quick - - - -																								7·178	20,083	6,335	5,297	104,335	8·965	2·828	2·367	46·577
Ratio in terms of the Crushing Force - - -																													·190	·054	·051	1·000

497.

MESSRS. BUTLIN AND CO., EAST END

No. 2.—

MANUFACTURE.

Grey Foundry Iron, first running from the furnace ;
The fluxes employed consist of an argillaceous limestone and a portion of chalk ; smelted by cold blast from Barnsley coal.

The following ingredients produce one ton of iron (No. 1):—

	Tons.	*cwt.*
Ore (not calcined)	2	18
Barnsley coal	2	16
Argillaceous limestone	0	10
Chalk	0	2

CASTING.

Cast — 2 October 1856.
Barometer — 29·80
Thermometer — 67·

Weight of—	*cwts.*	*qrs.*	*lbs.*
Charge	5	0	0
Castings	4	0	4
Runners	0	1	21
Slag and waste	1	0	0
Coals consumed	4	1	7

Time of—	*hrs.*	*min.*
Melting	1	0
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1432			1	–	–	–	–	–	–	–	–	–	–	–	–
1433	Mark $\frac{9}{2}$.	Slow	2	–	–	–	–	–	–	–	–	–	–	–	–
1434			3	–	–	–	–	–	–	–	–	–	–	–	–
1435	CAST.		1	–	–	–	–	–	–	–	–	–	–	–	–
1436	2 October 1856.	Horizontal. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1437			3	–	–	–	–	–	–	–	–	–	–	–	–
1438	TESTED.		1	–	–	–	–	–	–	–	–	–	–	–	–
1439	Transverse, 3 Aug. 1857.	Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1440	Temp. 80°.		3	–	–	–	–	–	–	–	–	–	–	–	–
1441			1	–	–	–	–	–	–	–	–	–	–	–	–
1442	FRACTURE.	Slow	2	–	–	–	–	–	–	–	–	–	–	–	–
1443	Light Grey in the centre, with a silvery margin.		3	–	–	–	–	–	–	–	–	–	–	–	–
1444	Regular.		1	–	–	–	–	–	–	–	–	–	–	–	–
1445	Fine Grain.	Vertical. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1446	This sample being too hard to turn into cylinders, could only be tested by Transverse strain.		3	–	–	–	–	–	–	–	–	–	–	–	–
1447			1	–	–	–	–	–	–	–	–	–	–	–	–
1448		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1449			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			–	–	–	–	–	–	–	–	–	–	–	–

TRANSVERSE. Dimensions. Breadth.	Depth.	B D²	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
2·03	1·99	8·0390	·060	·002	–	–	–	–	·094	7,500	4,643
1·99	1·99	7·8805	·055	·001	–	–	–	–	·084	7,400	4,695
–	–	–	–	–	–	–	–	–	–	–	–
1·96	2·05	8·2369	·056	·002	–	–	–	–	·095	8,300	5,038
1·96	2·01	7·9185	·053	·005	–	–	–	–	·091	8,000	5,051
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
1·96	1·99	7·7617	·050	·001	–	–	–	–	·066	6,200	3,993
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
1·94	1·95	7·3768	·052	·001	–	–	–	–	·073	6,900	4,676
1·96	1·97	7·6065	·050	·001	–	–	–	–	·096	9,600	6,310
–	–	–	–	–	–	–	–	–	–	–	–
1·98	1·99	7·8409	·048	·002	–	–	–	–	·078	8,300	5,292
1·99	1·99	7·8805	·049	·005	–	–	–	–	·060	6,500	4,124
–	–	–	–	–	–	–	–	–	–	–	–
1·98	1·99	7·8409	·052	·002	–	–	–	–	·082	7,633	4,869

TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 38, at the end.

IRON WORKS, WELLINGBORO', NORTHAMPTONSHIRE.

MOTTLED IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·10
Silicon	2·11
Sulphur	0·13
Phosphorus	1·07
Manganese	0·08

The amount of combined carbon has not been determined.

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,669	- -	- -	- -	2·084	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,044	- -	- -	- -	2·251	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	3,993	- -	- -	- -	1·782	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,493	- -	- -	- -	2·452	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,708	- -	- -	- -	2·101	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,869	- -	- -	- -	2·173	—	—

Combined Means	Slow, Gradual and Quick cooling	Horizontal	- - - -	- - - -	4,856	- - - -	- -	2·167	—	—
		Vertical	- - - -	- - - -	4,879	- - - -	- -	2·178	—	—
	Horizontally and Vertically cast	Slow	- - - - -	- - - -	4,331	- - - -	- -	1·933	—	—
		Gradual	- - - - -	- - - -	5,268	- - - -	- -	2·351	—	—
		Quick	- - - - -	- - - -	4,708	- - - -	- -	2·101	—	—
				Ratio in terms of the Crushing Force				—	—	—	—

EAST END IRON WORKS, WELLINGBOROUGH, NORTHAMPTONSHIRE.

(Messrs. Bullin and Co.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ore.

Three samples of the ochrey-brown ironstone of the district were forwarded. They were of various degrees of hardness and density, though all consisted principally of hydrated peroxide of iron. An average sample was prepared for the purpose of analysis.

Peroxide of iron	76·00
Protoxide of iron	*trace.*
Oxide of manganese	0·40
Alumina	2·30
Carbonate of lime	0·41
Carbonate of magnesia	0·11
Phosphoric acid	1·03
Water, hygroscopic	1·80
Water, in combination	12·40
Insoluble residue (silica, almost entirely, with a trace of mica)	5·33
	99·78
Metallic iron	53·20

The ore does not contain any appreciable amount of sulphur.

Fuel.

Barnsley Coal, employed without being previously coked.

An average sample contained—

Sulphur - - - - - - - - 0·65 per cent.

and left on burning,

Ash - - - - - - - - 4·76 per cent.

the ash consisting of shale, *silicate of alumina,* with a little *peroxide of iron,* and traces of *lime* and *magnesia.*

On heating in a close crucible, the coal yielded 76·36 per cent. of *coke.*

EAST END IRON WORKS, WELLINGBOROUGH, NORTHAMPTONSHIRE—*continued.*

FLUXES.

Two descriptions of flux are employed,—Argillaceous limestone, and a small proportion of chalk.

Argillaceous Limestone, pale yellow in colour, oolitic in structure.

Carbonate of lime	89·36
Carbonate of iron	3·38
Carbonate of magnesia	0·97
Water	0·43
Organic matter	*trace.*
Ferruginous clay, and sand	6·00
	100·14

Chalk.—The ordinary quality, consisting of *carbonate of lime,* with traces only of *silica, alumina, peroxide of iron,* and *carbonate of magnesia.*

IRONS.

I. No. 1 Pig iron (cold blast).

II. Mottled iron (cold blast).

Important Constituents in 100 *Parts.*

	I.	II.
Carbon, as graphite	2·85	2·10
Silicon	1·92	2·11
Sulphur	0·10	0·13
Phosphorus	1·19	1·07
Manganese	0·24	0·08

The amount of combined carbon in the mottled iron has not been determined.

Remark.—The per-centage of phosphorus in the samples of iron is such as would have been predicted, from the large proportion borne by the phosphoric acid to the iron in the ore employed.

MESSRS. JUDKINS, HEYFORD

PIG IRON,

MANUFACTURE.

Pig Iron, manufactured from the following ingredients, viz.: Iron ore found in large quantity near the surface of the earth in Northamptonshire, lying in beds from 5 feet to 35 feet in thickness.

Limestone used as flux, found in large quantities in Northamptonshire, more particularly near Blisworth.

The coal from the mines of the South Yorkshire Railway Company, near Barnsley, converted into coke, used as fuel.

The sample is direct from the smelting furnace.

CASTING.

Cast - - - 10 October 1856.

Barometer - - - 30·24

Thermometer - - - 64·

Weight of—

	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	1	27
Runners - -	0	1	13
Slag and waste -	0	1	24
Coals consumed -	3	1	23

Time of—

	hrs.	min.
Melting - - -	0	50
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting - -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1774	Mark $\frac{18}{1}$.	Horizontal. Slow -	1	6·838	1·3	·000	–	–	–	–	–	–	·002	14,900	11,225
1775			2	6·847	1·3	·000	–	–	–	–	–	–	·001	14,800	11,150
1776	CAST.		3	6·850	1·299	·000	–	–	–	–	–	–	·002	14,500	11,242
1777	10 October 1856.		1	6·960	1·3	.000	–	–	–	–	–	–	·001	14,200	10,698
1778	TESTED.	Gradual	2	6·964	1·3	·000	–	–	–	–	–	–	·002	14,100	10,622
1779	Tensile, 1 Feb. 1858. Temp. 60°.		3	6·966	1·3	·000	–	–	–	–	–	–	·003	14,500	10,924
1780	Transverse, 28 Oct. 1857.		1	6·882	1·3	·000	–	–	–	–	–	–	·003	14,800	11,150
1781	Temp. 57°.	Quick -	2	6·915	1·3	·000	–	–	–	–	–	–	·001	13,800	10,397
1782	Torsion, 24 Nov. 1857.		3	6·880	1·3	·000	–	–	–	–	–	–	·002	14,900	11,225
1783	Temp. 57°.		1	6·822	1·3	·000	–	–	–	–	–	–	·002	13,900	10,472
1784	Crushing, 1 Feb. 1859.	Slow -	2	6·892	1·299	·002	–	–	–	–	–	–	·004	15,000	11,997
1785	Temp. 54°.		3	–	–	–	–	–	–	–	–	–	–	–	–
1786	FRACTURE. Bright Grey.	Vertical.	1	6·875	1·3	·005	–	–	–	–	–	–	·006	15,700	11,827
1787	Regular.	Gradual	2	6·838	1·3	·000	–	–	–	–	–	–	·001	13,800	10,397
1788	Fine Grain.		3	–	–	–	–	–	–	–	–	–	–	–	–
1789	Difficult working.		1	6·873	1·3	·000	–	–	–	–	–	–	·003	12,500	9,417
1790		Quick -	2	6·896	1·3	·000	–	–	–	–	–	–	·005	13,600	10,246
1791			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN - - -			6·886	1·3	·000	–	–	–	–	–	–	·002	14,420	10,866

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1774	2·00	2·00	8·0000	–	–	–	–	–	–	·070	4,500	2,812	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1775	2·01	1·97	7·8006	·073	·007	–	–	–	–	·080	5,400	3,461	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1776	–	–	–	–	–	–	–	–	–	–	–	–	1·797	–	–	–	–	–	–	–	–	–	–	–	–	1°·6
1777	2·02	1·97	7·8394	·080	·008	–	–	–	–	·092	5,500	3,507	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1778	2·06	2·01	8·3226	·055	·005	–	–	–	–	·092	5,600	3,364	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1779	–	–	–	–	–	–	–	–	–	–	–	–	1·790	–	–	–	–	–	–	–	–	–	–	–	–	1°·7
1780	2·02	2·01	8·1610	·070	·005	–	–	–	–	·084	5,500	3,369	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1781	1·99	2·05	8·3629	·086	·020	–	–	–	–	·095	5,700	3,407	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1782	–	–	–	–	–	–	–	–	–	–	–	–	1·791	–	–	–	–	–	–	–	–	–	–	–	–	2°·5
1783	1·99	2·03	8·2005	–	–	–	–	–	–	·090	4,500	2,743	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1784	1·98	1·98	7·7623	–	–	–	–	–	–	·069	4,500	2,905	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1785	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1786	2·04	2·03	8·4066	–	–	–	–	–	–	·075	4,500	2,676	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1787	2·01	2·01	8·1206	–	–	–	–	–	–	·062	4,200	2,586	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1788	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1789	2·00	2·07	8·5698	·071	·013	–	–	–	–	·112	5,250	3,063	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1790	1·99	2·00	7·9600	–	–	–	–	–	–	·067	4,900	3,017	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1791	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2·01	2·01	8·1206	·072	·009	–	–	–	–	·082	5,004	3,075	1·793	–	–	–	–	–	–	–	–	–	–	–	–	1°·9

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 39, at the end.

IRON WORKS, NEAR WEEDON.

FIRST MELTING.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·64
Silicon	4·63
Sulphur	0·07
Phosphorus	1·31
Manganese	trace.

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·845	11,205	3,136	3,877	76,040	5·002	1·400	1·730	33·946
900	3,877	30°	1·72	1·3	·6	2·16	·015	·001	·014	·026	·005	·021	-	-	-	-	-	-	-	-	-	21,500	76,040									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·963	10,748	3,435	3,705	81,345	4·800	1·533	1·654	36·314
850	3,705	30°	1·78	1·3	·6	2·16	·015	·000	·015	·024	·001	·023	-	-	-	-	-	-	-	-	-	23,000	81,345									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·892	10,924	3,388	4,134	75,686	4·876	1·512	1·845	33·788
950	4,134	35°	1·38	1·3	·6	2·16	·015	·000	·015	·027	·003	·024	-	-	-	-	-	-	-	-	-	21,400	75,686									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·857	11,234	2,824	- -	- -	5·061	1·260	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·856	11,112	2,631	- -	- -	4·960	1·174	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·884	9,831	3,040	- -	- -	4·388	1·357	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
900	3,905	32°	1·62	1·3	·6	2·16	·015	·000	·015	·026	·003	·023	-	-	-	-	-	-	-	-	-	21,967	77,690	6·886	10,866	3,075	3·905	77,690	4·850	1·372	1·743	34·683
Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - -																								6·900	10,959	3,320	3,905	77,690	4·892	1·482	1·743	34·683
																								Vertical - - - -									6·866	10,726	2,831	- -	- -	4·791	1·263	—	—
Horizontally and Vertically cast - - - Slow - - - - -																								6·801	11,219	2,980	3,877	76,040	5·008	1·330	1·730	33·946
																								Gradual - - - -									6·920	10,930	3,033	3,705	81,345	4·879	1·354	1·654	36·314
																								Quick - - - -									6·888	10,377	3,214	4,134	75,686	4·632	1·434	1·845	33·788
																													Ratio in terms of the Crushing Force - - -					·139	·039	·050	1·000

HEYFORD IRON WORKS, NEAR WEEDON.

(Mr. J. Judkins.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ore.

Ochrey brown ironstone (hydrated peroxide of iron) from the same district, and similar in general character to the ore from Wellingbro' (series preceding). The sample analysed was an average of the two specimens received.

Peroxide of iron	56·20
Protoxide of iron	*trace.*
Oxide of manganese	0·20
Alumina	2·43
Carbonate of lime	0·49
Carbonate of magnesia	0·17
Phosphoric acid	0·84
Water, hygroscopic	1·16
Water, in combination	9·74
Insoluble residue, consisting of quartz, soluble silica, and a little mica	29·07
	100·30
Metallic iron	39·34

No appreciable amount of sulphur was detected in the ore.

Fuel.

The coal of the South Yorkshire Railway Company, near Barnsley, from which the coke used at the works is prepared, contained—

Sulphur - - - - - - - - 0·65 per cent.

Coke, made from Barnsley Coal. An average sample contained—

Sulphur - - - - - - - - 0·52 per cent.

and left, on burning,

Ash - - - - - - - - - 6·58 per cent.

the red ash consisting of *silicate of alumina*, with *peroxide of iron*, and traces of *lime* and *magnesia*.

Flux.

Limestone, light coloured; composed entirely of an agglomeration of fossil shells.

(Sample dried at 212° Fahrenheit.)

Carbonate of lime	96·86
Carbonate of magnesia	0·90
Carbonate of iron	1·36
Silicious matter	0·88
	100·00

HEYFORD IRON WORKS, NEAR WERDON—*continued.*

IRON.

Specified as "Pig iron, first melting."

Important Constituents in 100 *Parts.*

Carbon, as graphite	2·64
Silicon	4·63
Sulphur	0·07
Phosphorus	1·31
Manganese	*trace.*

Remark.—The considerable amount of phosphorus in this iron may be traced to the large proportion which the phosphoric acid in the ore employed bears to the per-centage of peroxide of iron.

It may also be observed, with reference to the high per-centage of silicon in the iron, that the ore contains an unusually large amount of silica in the condition in which it possesses most active chemical affinities, and that a pure limestone flux is employed in this instance with an ore comparatively free from alumina, by which a blast furnace-cinder of unusual composition would be produced, which may have some influence in determining the proportion of the silicon in the iron.

FOREST OF DEAN COMPANY, PARKEND IRON

No. 1.—

MANUFACTURE.

Pig Iron of the first melting. The ores are all hæmatite, and smelted entirely with coke, no raw coal being used.

The whole of the fuel, flux, and ores consumed in making this iron are raised in Her Majesty's Forest of Dean.

Cast - - 26 September 1856.
Barometer - - - 29·62
Thermometer - - - 64·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	4	0	11
Runners - -	0	2	15
Slag and Waste	0	2	11
Coals consumed	3	2	26

Time of—	hrs.	min.
Melting - - -	0	35
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - - -	4	0
Quick - - -	0	30
Tapping after melting - -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1180	Mark $\frac{4}{1}$.	Horizontal. Slow	1	7·117	1·3	·003	–	–	–	–	–	–	·020	18,000	13,561	2·01	1·98	7·8800	·073	·005	–	–	–	–	·176	9,000	5,710	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1181			2	7·121	1·3	·003	–	–	–	–	–	–	·012	17,500	13,184	2·01	2·01	8·1206	·085	·008	–	–	–	–	·186	9,000	5,541	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1182	CAST.		3	7·102	1·3	·002	–	–	–	–	–	–	·008	16,600	12,506	–	–	–	–	–	–	–	–	–	–	–	–	1·8	–	–	–	–	–	–	–	–	–	–	–	–	11°
1183	26 September 1856.		1	7·114	1·3	·002	–	–	–	–	–	–	·009	16,800	12,657	2·02	2·00	8·0800	·070	·005	–	–	–	–	·178	9,400	5,759	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1184	TESTED.	Horizontal. Gradual	2	7·141	1·297	·003	–	–	–	–	–	–	·005	17,000	12,867	2·02	2·02	8·2420	·078	·010	–	–	–	–	·191	9,500	5,762	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1185	Tensile, 3 June 1857.		3	7·113	1·3	·018	–	–	–	–	–	–	·018	15,000	11,300	–	–	–	–	–	–	–	–	–	–	–	–	1·797	10·5	5·	5·5	–	–	–	–	–	–	–	–	–	12°·5
	Temp. 65°.																																									
1186			1	7·119	1·298	·000	–	–	–	–	–	–	·005	17,800	13,451	2·05	1·97	7·9558	·071	·008	–	–	–	–	·177	9,200	5,781	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Transverse, 3 April 1857.																																									
1187	Temp. 60°.	Quick	2	7·109	1·299	·001	–	–	–	–	–	–	·007	17,700	13,445	2·01	1·98	7·8800	·075	·004	–	–	–	–	·180	9,600	6,091	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1188			3	7·114	1·3	·001	–	–	–	–	–	–	·001	17,000	12,807	–	–	–	–	–	–	–	–	–	–	–	–	1·796	8·	3·	5·	–	–	–	–	–	–	–	–	–	11°·2
	Torsion, 2 May 1857.																																									
	Temp. 50°.																																									
1189			1	7·128	1·298	·011	–	–	–	–	–	–	·011	15,000	11,335	1·97	2·00	7·8800	·082	·010	–	–	–	–	·160	8,000	5,076	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1190	Crushing, 25 Jan. 1859.	Slow	2	7·129	1·298	·004	–	–	–	–	–	–	·004	15,500	11,986	1·98	1·97	7·6831	·080	·006	–	–	–	–	·149	7,200	4,684	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1191	Temp. 52°.		3	7·101	1·3	·004	–	–	–	–	–	–	·005	16,800	12,657	–	–	–	–	–	–	–	–	–	–	–	–	1·797	–	–	–	–	–	–	–	–	–	–	–	–	12°
1192	FRACTURE.	Vertical.	1	7·124	1·298	·001	–	–	–	–	–	–	·009	15,900	12,015	1·99	1·99	7·8805	·075	·006	–	–	–	–	·176	8,500	5,392	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Medium Grey.																																									
1193	Lustrous.	Gradual	2	7 092	1·292	·003	–	–	–	–	–	–	·012	16,300	12,432	1·98	2·01	7·9093	·081	·008	–	–	–	–	·153	7,400	4,625	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1194	Coarse Grain.		3	7·119	1·3	·000	–	–	–	–	–	–	·002	17,400	13,108	–	–	–	–	–	–	–	–	–	–	–	–	1·8	–	–	–	–	–	–	–	–	–	–	–	–	9°·5
	Irregular.																																									
1195	Good and soft in working.		1	7·107	1·3	·004	–	–	–	–	–	–	·010	15,500	11,677	1·96	1·95	7·4529	·092	·014	–	–	–	–	·123	5,500	3,689	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1196		Quick	2	7·107	1·3	·004	–	–	–	–	–	–	·010	16,200	12,205	1·96	1·97	7·6065	·085	·007	–	–	–	–	·142	6,900	4,535	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1197			3	7·115	1·3	·004	–	–	–	–	–	–	·015	17,000	13,485	–	–	–	–	–	–	–	–	–	–	–	–	1·8	9·5	4·	5·5	–	–	–	–	–	–	–	–	–	13°
	General Mean			7·115	1·299	·004	–	–	–	–	–	–	·009	16,661	12,593	1·99	1·99	7·8805	·079	·007	–	–	–	–	·180	8,266	5,220	1·798	9·3	4·	5·3	–	–	–	–	–	–	–	–	–	11°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 40, at the end.

WORKS, NEAR LYDNEY, GLOUCESTERSHIRE.

FOUNDRY PIG.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·26
Silicon	2·34
Sulphur	0·04
Phosphorus	0·14
Manganese	0·23

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·113	13,083	5,625	4,243	54,819	5·840	2·511	1·894	24·472
990	4,243	36°	1·60	1·3	·6	2·16	·045	·033	·012	-	-	-	-	-	-	-	-	-	-	-	-	15,500	54,819									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·122	12,274	5,760	4,739	55,173	5·479	2·571	2·115	24·629
1,100	4,739	35°	1·36	1·3	·6	2·16	·043	·029	·014	-	-	-	-	-	-	-	-	-	-	-	-	15,600	55,173									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·114	13,234	5,936	4,790	56,588	5·908	2·649	2·138	25·262
1,110	4,790	44°	1·60	1·3	·6	2·16	·035	·018	·017	-	-	-	-	-	-	-	-	-	-	-	-	16,000	56,588									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·119	11,992	4,880	4,308	54,819	5·353	2·178	1·923	24·472
1,000	4,308	34°	1·64	1·3	·6	2·16	·056	·040	·016	-	-	-	-	-	-	-	-	-	-	-	-	15,500	54,819									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·111	12,518	5,008	4,286	56,588	5·588	2·235	1·913	25·262
1,000	4,286	37°	1·43	1·3	·6	2·16	·047	·028	·019	-	-	-	-	-	-	-	-	-	-	-	-	16,000	56,588									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·109	12,455	4,112	4,501	58,710	5·560	1·835	2·009	26·209
1,050	4,501	35°	2·05	1·3	·6	2·16	·039	·023	·016	-	-	-	-	-	-	-	-	-	-	-	-	16,600	58,710									
1,041	4,478	37°	1·61	1·3	·6	2·16	·044	·028	·016	-	-	-	-	-	-	-	-	-	-	-	-	15,867	56,116	7·115	12,593	5,220	4,478	56,116	5·621	2·330	1·999	25·049
Combined Means - - - Slow, Gradual, and Quick cooling - - Horizontal - - -																								7·116	12,864	5,774	4,590	55,527	5·742	2·577	2·044	24·788
Vertical - - - -																								7·113	12,322	4,669	4,365	56,706	5·500	2·084	1·948	25·315
Horizontally and Vertically cast - - Slow - - - - -																								7·116	12,537	5,252	4,275	54,819	5·596	2·344	1·908	24·472
Gradual - - - -																								7·117	12,396	5,384	4,512	55,880	5·533	2·403	2·014	24·946
Quick - - - -																								7·114	12,844	5,024	4,645	57,649	5·733	2·242	2·073	25·736
																								Ratio in terms of the Crushing Force - - -					·224	·093	·079	1·000

FOREST OF DEAN COMPANY, PARK END IRON

GREY

MANUFACTURE.

Pig Iron of the first melting. The ores are all hæmatite and smelted entirely with coke, no raw coal being used.

The whole of the fuel, flux, and ores consumed in making this iron are raised in Her Majesty's Forest of Dean.

CASTING.

Cast	26 September 1856.
Barometer	29·62
Thermometer	64°

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	22
Runners	0	2	7½
Slag and waste	0	3	19½
Coals consumed	3	1	24

Time of—	hrs.	min.
Melting	0	35
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1198			1	7·169	1·3	·003	·005	–	–	–	–	–	·008	21,500	16,198	2·01	2·01	8·1206	·057	·002	·140	·019	–	–	·166	11,500	7,080	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1199	Mark $\frac{4}{2}$.	Slow	2	7·182	1·3	·009	·012	–	–	–	–	–	·014	24,000	18,081	2·02	2·00	8·0800	·061	·004	·148	·021	–	–	·200	11,800	7,301	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1200			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	CAST.																																									
1201	26 September 1856.		1	7·178	1·3	·002	·006	–	–	–	–	–	·008	22,000	16,574	1·98	1·97	7·6831	·068	·010	·165	·032	–	–	·188	10,800	7,027	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1202		Horizontal. Gradual	2	7·184	1·3	·002	·005	–	–	–	–	–	·008	23,000	17,328	2·01	1·97	7·8006	·061	·002	·150	·021	–	–	·156	10,300	6,602	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1203	TESTED.		3	7·172	1·3	·001	·006	–	–	–	–	–	·006	20,000	15,067	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·7	1·4	2·3	–	–	–	–	–	–	–	–	–	12°·3
	Tensile, 3 June 1857.																																									
	Temp. 65°.																																									
1204			1	7·177	1·3	·003	·007	–	–	–	–	–	·009	20,700	15,594	2·03	2·00	8·1200	·064	·001	·146	·020	–	–	·203	12,400	7,635	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1205	Transverse, 3 April 1857.	Quick	2	7·169	1·3	·002	·006	–	–	–	–	–	·008	24,600	18,533	2·02	2·00	8·0800	·070	·014	·152	·030	–	–	·208	12,300	7,611	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Temp. 60°.																																									
1206			3	7·170	1·3	·001	·005	–	–	–	–	–	·007	23,800	17,931	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·1	·8	2·3	–	–	–	–	–	–	–	–	–	11°·
	Torsion, 4 May 1857.																																									
	Temp. 55°.																																									
1207			1	7·167	1·3	·002	·006	–	–	–	–	–	·011	21,500	16,198	2·00	2·00	8·0000	·060	·003	–	–	–	–	·142	9,700	6,062	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1208		Slow	2	7·173	1·293	·002	·006	–	–	–	–	–	·009	22,900	17,440	1·96	1·99	7·7617	·063	·003	–	–	–	–	·152	9,800	6,312	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Crushing, 1 Feb. 1859.																																									
1209	Temp. 54°.		3	7·175	1·3	·002	·005	–	–	–	–	–	·007	21,700	16,348	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3 2	·4	2·8	–	–	–	–	–	–	–	–	–	10°·1
1210			1	7·189	1·3	·002	·006	–	–	–	–	–	·008	23,200	17,479	1·98	2·04	8·2399	·057	·003	–	–	–	–	·121	9,000	5,461	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1211	FRACTURE.	Vertical. Gradual	2	7·195	1·3	·063	·006	–	–	–	–	–	·008	24,100	18,156	1·99	2·01	8·0397	·058	·004	–	–	–	–	·132	9,300	5,783	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1212	Bright Grey.		3	7·164	1·3	·003	·007	–	–	–	–	–	·009	22,300	16,800	–	–	–	–	–	–	–	–	–	–	–	–	1·8	4·	2·	2·	–	–	–	–	–	–	–	–	–	13°·
	Regular.																																									
	Medium Grain.																																									
1213	Good working qualities.		1	7·180	1·3	·003	·007	–	–	–	–	–	·008	23,500	17,705	2·00	2·03	8·2418	·061	·006	·140	·020	–	–	·180	12,100	7,340	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1214		Quick	2	7·186	1·3	·003	·007	–	–	–	–	–	·009	23,000	17,328	1·99	2·00	7·9600	·058	·008	·138	·018	–	–	·160	11,400	7,160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1215			3	7·177	1·3	·003	·007	–	–	–	–	–	·012	22,000	16,574	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·3	·4	2·9	–	–	–	–	–	–	–	–	–	8°·
	GENERAL MEAN			7·176	1·3	·003	·006	–	–	–	–	–	·009	22,577	17,019	2·00	2·00	8·0000	·061	·005	·147	·022	–	–	·167	10,866	6,781	1·799	3·5	1·	2·5	–	–	–	–	–	–	–	–	–	10°·9

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 41, at the end.

WORKS, NEAR LYDNEY, GLOUCESTERSHIRE.

F O R G E.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·08
Silicon	2·18
Sulphur	0·06
Phosphorus	0·14
Manganese	0·14

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -								
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7·175	17,139	7,190	- -	- -	7·651	3·209	—	—
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -								
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -								
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7·178	16,323	6,814	6,322	71,681	7·287	3·041	2·822	32·000
1,470	6,322	41°	1·97	1·3	·599	2·17	·015	·005	·010	·055	·039	·016	- -	- -	- -	- -	- -	- -	- -	- -	- -	20,200	71,681									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -								
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7·172	17,352	7,623	6,430	76,040	7·746	3·403	2·870	33·946
1,500	6,430	40°	1·30	1·3	·6	2·16	·020	·007	·013	·046	·025	·021	- -	- -	- -	- -	- -	- -	- -	- -	- -	21,500	76,040									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -								
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7·171	16,662	6,187	6,011	70,381	7·438	2·762	2·683	31·420
1,400	6,011	36°	2·10	1·3	·6	2·16	·025	·010	·015	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	19,900	70,381									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -								
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7·182	17,478	5,622	6,387	72,503	7·802	2·509	2·851	32·367
1,490	6,387	40°	1·95	1·3	·6	2·16	·024	·011	·013	·045	·028	·017	- -	- -	- -	- -	- -	- -	- -	- -	- -	20,500	72,503									
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -								
- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	7·181	17,202	7,250	6,011	76,394	7·679	3·236	2·683	34·104
1,400	6,011	40°	2·02	1·3	·6	2·16	·019	·005	·014	·043	·021	·022	- -	- -	- -	- -	- -	- -	- -	- -	- -	21,600	76,394									
1,452	6,232	39°	1·87	1·3	·6	2·16	·021	·008	·013	·047	·028	·019	- -	- -	- -	- -	- -	- -	- -	- -	- -	20,740	73,400	7·176	17,019	6,781	6,232	73,400	7·597	3·027	2·782	32·767
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																						7·175	16,913	7,209	6,376	73,861	7·550	3·218	2·846	32·973
Vertical - - - -																						7·178	17,114	6,353	6,136	73,093	7·640	2·836	2·739	32·630
Horizontally and Vertically cast - - - Slow - - - - -																						7·173	16,900	6,688	6,011	70,381	7·544	2·985	2·683	31·420
Gradual - - - -																						7·180	16,900	6,218	6,354	72,092	7·544	2·775	2·836	32·183
Quick - - - - -																						7·177	17,277	7,436	6,220	76,217	7·712	3·319	2·776	34·025
																											Ratio in terms of the Crushing Force - - -				·231	·092	·084	1·000

PARK END FURNACES, FOREST OF DEAN.

(Mr. Charles Greenham.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

The Ores employed are purple-brown hæmatite; samples of two descriptions were received.

I. *Brush Ore, Forest of Dean.*—The sample was composed mainly of fragments of the purple-brown hydrated peroxide of iron, having the peculiar stalactitic structure which characterises this ore. A smaller quantity of the ochrey-brown pulverulent variety was intermixed with the former, and therefore included in the sample analysed.

Peroxide of iron	90·70
Protoxide of iron, Oxide of manganese, Lime	*traces.*
Phosphoric acid	0·07
Water	8·87
Sand and clay	0·60
	100·24
Metallic iron	63·50

II. "*Grey Vein,*" *Forest of Dean.*—This ore appears to have been derived from the brush ore, by the partial filling up of the cavities with a crystallised double carbonate of lime and magnesia.

Peroxide of iron	41·86
Protoxide of iron, Oxide of manganese	*traces.*
Carbonate of lime	30·40
Carbonate of magnesia	21·50
Phosphoric acid	0·13
Water	4·65
Sand and clay	1·32
	99·86
Metallic iron	29·30

Neither of these ores contain any appreciable amount of sulphur.

PARK END FURNACES, FOREST OF DEAN—*continued.*

The FUEL employed is coke, prepared from Forest of Dean coal.

An average sample of the coke contained—

Sulphur - - - - - - - - - 0·90 per cent.

and left, on burning,

Ash - - - - - - - - - 8·20 per cent.

the ash consisting of burnt shale, and containing *silica, alumina, peroxide of iron, lime* and *magnesia.*

FLUX.

This is a burnt shale, reddish in colour, and bearing impressions of fossil ferns. It consists of *silicate of alumina,* with *peroxide of iron,* and a little *lime* and *magnesia.*

IRONS.

Important Constituents in 100 *Parts.*

	No. 1, Pig Iron.	Grey Forge.
Carbon, as graphite - - - - -	3·26	3·08
Silicon - - - - - - -	2·34	2·18
Sulphur - - - - - - -	0·04	0·06
Phosphorus - - - - - -	0·14	0·14
Manganese - - - - - -	0·23	0·14

MESSRS. PALMER AND BUDD,

No. 1.—FOUNDRY—

MANUFACTURE.

No. 1.—Anthracite Pig Iron of the second melting, smelted and manufactured from the following materials:—

Anthracite, or stone coal, from the "Little Vein."
Argillaceous ironstone, known as { Cws-y-glo or Cheese Mine. / Pinmelyn or Yellow Pin.
Hæmatite iron ore, from Lancashire.
Limestone used as a flux.

CASTING.

Cast	17 September 1856.
Barometer	29·97
Thermometer	61°

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	3
Runners	0	1	8
Slag and waste	1	0	4
Coals consumed	3	2	13

Time of—	hrs.	min.
Melting	0	35
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1073	Mark $\frac{3}{1}$.	Horizontal. Slow	1	7·165	1·3	·002	·003	·005	·010	–	–	–	·012	35,000	26,368
1074			2	–	–	–	–	–	–	–	–	–	–	–	–
1075	CAST.		3	7·182	1·3	·002	·004	·006	·008	·012	–	–	·013	35,900	27,046
1076	17 September 1856.	Horizontal. Gradual	1	7·127	1·3	·004	·006	·008	·010	–	–	–	·011	33,800	25,465
1077	TESTED.		2	7·171	1·3	·002	·005	·008	·009	–	–	–	·011	33,700	25,389
1078	Tensile, 28 May 1857. Temp. 66°.		3	7·176	1·3	·002	·005	·008	·010	–	–	–	·012	33,000	24,862
1079	Transverse, 30 Jan. 1857.	Horizontal. Quick	1	7·172	1·3	·002	·004	·006	·008	·011	–	–	·013	37,200	28,026
1080	Temp. 53°.		2	7·171	1·3	·003	·005	·006	·008	·011	–	–	·014	37,700	28,402
1081	Torsion, 27 April 1857.		3	7·192	1·3	·002	·005	·007	·008	·011	–	–	·015	37,100	27,950
1082	Temp. 58°.	Vertical. Slow	1	7·118	1·3	·000	·004	·007	·009	–	–	–	·014	31,500	23,732
1083	Crushing, 2 Feb. 1859.		2	7·136	1·3	·002	·005	·007	·010	–	–	–	·012	33,900	25,540
1084	Temp. 56°.		3	7·162	1·3	·003	·005	·007	·009	–	–	–	·011	32,500	24,485
1085	FRACTURE.	Vertical. Gradual	1	7·175	1·3	·002	·005	·007	·009	–	–	–	·011	34,800	26,218
1086	Medium Dull Grey. Regular.		2	7·135	1·3	·002	·004	·005	·007	–	–	–	·008	34,500	25,992
1087	Fine Grain. Good working qualities.		3	7·180	1·3	·003	·005	·007	·008	–	–	–	·010	34,900	26,293
1088		Vertical. Quick	1	7·098	1·3	·004	·007	·009	·011	–	–	–	·012	32,400	24,400
1089			2	7·259	1·3	·001	·004	–	–	–	–	–	·004	20,000*	15,067*
1090			3	7·188	1·3	·000	·002	·004	·005	–	–	–	·006	30,100	22,676
	GENERAL MEAN			7·165	1·3	·002	·004	·007	·009	·011	–	–	·011	33,412*	25,172*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1073	2·03	1·97	7·8782	·060	·004	·136	·019	–	–	·210	14,000	8,885	–	–	–	–	–	–	–	–	–	–	–	–	–
1074	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1075	–	–	–	–	–	–	–	–	–	–	–	–	1·8	3·	·3	2·7	11·	7·	4·	–	–	–	–	–	18°·
1076	2·01	2·00	8·0400	·054	·004	·122	·015	–	–	·210	15,000	9,328	–	–	–	–	–	–	–	–	–	–	–	–	–
1077	2·03	2·00	8·1200	·052	·002	·120	·015	–	–	·220	14,800	9,113	–	–	–	–	–	–	–	–	–	–	–	–	–
1078	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·	·3	2·7	–	–	–	–	–	–	–	–	8°·5
1079	2·02	1·99	7·9994	·050	·005	·124	·015	–	–	·220	14,700*	9,188*	–	–	–	–	–	–	–	–	–	–	–	–	–
1080	1·98	2·04	8·2399	·054	·005	·120	·013	–	–	·200	14,500	8,798	–	–	–	–	–	–	–	–	–	–	–	–	–
1081	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·	·3	2·7	8·5	5·	3·5	–	–	–	–	–	17°·
1082	1·97	1·95	7·4909	·060	·005	–	–	–	–	·132	10,000*	6,674*	–	–	–	–	–	–	–	–	–	–	–	–	–
1083	1·97	1·97	7·6453	·059	·008	·130	·018	–	–	·164	11,900	7,782	–	–	–	–	–	–	–	–	–	–	–	–	–
1084	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·	·5	2·5	–	–	–	–	–	–	–	–	8°·
1085	1·96	1·98	7·6839	·050	·004	·120	·011	–	–	·165	12,400	8,068	–	–	–	–	–	–	–	–	–	–	–	–	–
1086	1·98	1·98	7·7623	·055	·004	·129	·015	–	–	·145	11,000	7,085	–	–	–	–	–	–	–	–	–	–	–	–	–
1087	–	–	–	–	–	–	–	–	–	–	–	–	1·8	2·5	·5	2·	8·	4·	4·	–	–	–	–	–	20°·
1088	1·98	1·97	7·6831	·056	·004	–	–	–	–	·134	10,000*	6,506*	–	–	–	–	–	–	–	–	–	–	–	–	–
1089	1·95	1·98	7·6447	·040	·005	–	–	–	–	·097	7,500*	4,905*	–	–	–	–	–	–	–	–	–	–	–	–	–
1090	–	–	–	–	–	–	–	–	–	–	–	–	1·798	–	–	–	–	–	–	–	–	–	–	–	2°·
	1·99	1·98	7·8015	·054	·005	·125	·015	–	–	·163	12,345*	7,848*	1·798	2·9	·4	2·5	9·1	5·3	3·8	–	–	–	–	–	12°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 42, at the end.

YSTALYFERA IRON WORKS, SWANSEA.

Second Melting.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·27
Silicon	1·87
Sulphur	0·05
Phosphorus	0·41
Manganese	0·27

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,700	7,287	32°	1·80	1·3	·6	2·16	·025	·011	·014	·053	·032	·021	·127	·097	·030	–	–	–	–	–	–	25,700	90,894	7·173	26,707	8,885	7,287	90,894	11·922	3·966	3·253	40·577
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,450*	6,246*	40°	1·90	1·3	·6	2·16	·060	·050	·010	–	–	–	–	–	–	–	–	–	–	–	–	15,500*	54,819*	7·158	25,238	9,220	6,246*	54,819*	11·266	4·116	2·788*	24·472*
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,820	7,827	40°	2·00	1·3	·6	2·16	·020	·008	·012	·046	·025	·021	·096	·067	·029	–	–	–	–	–	–	26,200	92,663	7·178	28,126	8,993*	7,827	92,663	12·556	4·014*	3·494	41·367
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,460	6,289	40°	1·92	1·3	·6	2·16	·020	·009	·011	0·47	·025	·022	·097	·069	·028	–	–	–	–	–	–	26,100	92,309	7·138	24,585	7,228*	6,289	92,309	10·975	3·226*	2·807	41·209
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,930	8,273	41°	2·00	1·3	·6	2·16	·015	·003	·012	·051	·021	·030	·102	·077	·025	–	–	–	–	–	–	25,800	91,248	7·163	26,167	7,576	8,273	91,248	11·681	3·382	3·693	40·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,000*	4,301*	45°	1·79	1·3	·6	2·16	·015	·003	·012	·035	·011	·024	·058	·029	·029	–	–	–	–	–	–	29,100	102,919	7·181	20,717*	5,705*	4,301*	102,919	9·248*	2·546*	1·920*	45·945
1,560*	6,704*	39°	1·90	1·3	·6	2·16	·026	·014	·012	·046	·023	·023	·096	·068	·028	–	–	–	–	–	–	24,733	87,475	7·165	25,172*	7,848*	6,704*	87,475*	11·237*	3·503*	2·992*	39·051*
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·169	26,688	9,062*	7,120*	79,459*	11·911	4·045*	3·178*	35·472*
Vertical - - - -																								7·161	23,823*	6,837*	6,287*	95,492	10·635*	3·052*	2·806*	42·630
Horizontally and Vertically cast - - - Slow - - - - -																								7·156	25,646	8,057*	6,788	91,552	11·449	3·596*	3·030	40·871
Gradual - - - -																								7·161	25,702	8,398	7,259*	73,033*	11·474	3·749	3·240*	32·604*
Quick - - - -																								7·179	24,421*	7,349*	6,064*	97,791	10·902	3·280*	2·707*	43·656
Ratio in terms of the Crushing Force - - -																													·287	·089	·076	1·000

MESSRS. PALMER AND BUDD,

No. 2.—FOUNDRY—

MANUFACTURE.

No. 2.—Anthracite Pig Iron, of the second melting, smelted and manufactured from the following materials :—

Anthracite, or stone coal, from the "Little Vein."
Argillaceous ironstone, known as { Cws-y-glo or Cheese Mine. / Pinmelyn or Yellow Pin.
Hæmatite iron ore, from Lancashire.
Limestone used as a flux.

CASTING.

Cast	18 September 1856.
Barometer	29·87
Thermometer	62·

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	4	0	5
Runners	0	1	12
Slag and waste	0	1	17
Coals consumed	3	1	2

Time of—	hrs.	min.
Melting	0	40
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1091			1	7·160	1·3	·003	·006	·009	·010	·011	–	–	·012	35,100	26,443	2·03	1·02	7·4833	·060	·005	·138	·016	–	–	·209	13,000	8,685	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1092	Mark $\frac{3}{2}$	Slow	2	7·175	1·3	·003	·007	·010	·011	·014	–	–	·015	37,500	28,252	1·98	2·01	7·9933	·053	·001	·123	·012	–	–	·235	15,000	9,374	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1093			3	7·136	1·3	·002	·005	·007	·008	–	–	–	·010	33,500	25,239	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·	·0	2·	7·5	3·5	4·	–	–	–	–	–	–	11°·0
1094	CAST.		1	7·180	1·3	·003	·006	·009	·011	·014	–	–	·015	36,300	27,348	2·02	1·99	7·9994	·050	·002	·120	·010	–	–	·180	14,000*	8,750*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1095	18 September 1856.	Horizontal. Gradual	2	7·171	1·3	·003	·006	·007	·009	·013	–	–	·014	36,600	27,574	2·00	2·02	8·1608	·051	·002	·120	·011	–	–	·188	14,000	8,577	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1096			3	7·195	1·3	·004	·008	·010	·012	·014	–	–	·016	36,400	27,423	–	–	–	–	–	–	–	–	–	–	–	–	1·794	3·5	1·	2·5	–	–	–	–	–	–	–	–	–	5°·5
1097	TESTED. Tensile, 29 May 1857. Temp. 64°.		1	7·187	1·3	·004	·008	·011	·012	·014	–	–	·016	37,400	28,176	2·04	1·99	8·0786	·058	·008	·125	·018	–	–	·231	15,000	9,283	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1098		Quick	2	7·173	1·3	·003	·006	·010	·011	·015	–	–	·017	37,200	28,026	1·99	2·03	8·2005	·051	·003	·120	·012	–	–	·194	14,000	8,535	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1099	Transverse, 30 Jan. 1857. Temp. 53°.		3	7·174	1·3	·001	·004	·007	·008	·011	–	–	·013	37,400	28,170	–	–	–	–	–	–	–	–	–	–	–	–	1·795	3·	·5	2·5	9·	5·	4·	–	–	–	–	–	–	14°·0
1101	Torsion, 28 April 1857.		1	7·151	1·3	·002	·006	·010	·012	–	–	–	·013	34,900	26,293	1·97	1·98	7·7231	·060	·006	·138	·020	–	–	·160	11,000	7,121	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1102	Temp. 54°.	Slow	2	7·084	1·3	·003	·006	·008	·011	–	–	–	·012	33,000	24,862	1·97	1·98	7·7231	·059	·004	·139	·017	–	–	·156	11,400	7,380	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1103	Crushing, 2 Feb. 1859. Temp. 56°.		3	7·158	1·3	·003	·007	·010	·011	–	–	–	·012	33,800	25,465	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·	·5	2·5	8·5	4·2	4·3	–	–	–	–	–	–	13°·0
1104			1	7·150	1·3	·003	·005	·008	·010	–	–	–	·012	33,500	25,230	2·01	1·98	7·8800	·051	·005	·152	·024	–	–	·160	10,100	6,408	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1105	FRACTURE.	Vertical. Gradual	2	7·164	1·3	·003	·006	·008	·011	–	–	–	·013	34,300	25,841	1·97	1·98	7·7231	·060	·007	·138	·019	–	–	·162	11,800	7,639	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1106	Medium Grey. Regular.		3	7·198	1·3	·002	·006	·008	·010	·012	–	–	·013	39,900	30,060	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·5	·5	3·	9·5	4·2	5·3	–	–	–	–	–	–	11°·0
1107	Fine Grain.		1	7·159	1·3	·002	·005	·006	·009	–	–	–	·011	31,000*	23,355*	2·00	1·99	7·9202	·055	·005	·126	·014	–	–	·149	11,200*	7,070*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1108	Good working qualities.	Quick	2	7·122	1·3	·003	·005	·008	·010	·012	–	–	·013	36,000	27,122	1·98	1·97	7·6831	·055	·003	–	–	–	–	·130	10,000*	6,506*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1109			3	7·108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1·797	–	–	–	–	–	–	–	–	–	–	–	–	3°·5
	GENERAL MEAN			7·157	1·3	·003	·006	·009	·010	·013	–	–	·013	35,517*	26,758*	1·99	1·98	7·8015	·055	·004	·131	·016	–	–	·196	12,541*	7,944*	1·797	3·	·5	2·5	8·6	4·2	4·4	–	–	–	–	–	–	9°·6

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 43, at the end.

YSTALYFERA IRON WORKS, SWANSEA.

Second Melting.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·92
Silicon	1·73
Sulphur	0·06
Phosphorus	0·29
Manganese	0·39

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,650	7,096	35°	2·16	1·3	·6	2·16	·023	·010	·013	·052	·028	·024	-	-	-	-	-	-	-	-	-	24,900	88,065	7·157	26,644	9,029	7,096	88,065	11·894	4·030	3·167	39·312
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200*	5,195*	35°	1·61	1·3	·6	2·16	·020	·010	·010	·056	·036	·020	·100	·070	·030	-	-	-	-	-	-	28,000	99,029	7·182	27,448	8,663*	5,195*	99,029	12·253	3·867*	2·319*	44·205
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,630	7,045	40°	1·84	1·3	·6	2·16	·020	·008	·012	043	·020	·023	-	-	-	-	-	-	-	-	-	24,000	84,882	7·178	28,126	8,909	7,045	84,882	12·556	3·977	3·145	37·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,670	7,170	40°	2·07	1·3	·6	2·16	·023	·009	·014	·049	·025	·024	·103	·072	·031	-	-	-	-	-	-	25,200	89,126	7·131	25,540	7,250	7,170	89,126	11·401	3·236	3·200	39·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,650	7,108	42°	2·08	1·3	·6	2·16	·020	·009	·011	·049	·017	·032	·105	·070	·035	-	-	-	-	-	-	26,000	91,955	7·169	27,046	7,023	7,108	91,955	12·074	3·135	7·173	41·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
800*	3,446*	42°	1·12	1·3	·6	2·16	·025	·012	·013	·053	·030	·023	·105	·075	·030	-	-	-	-	-	-	26,100	92,309	7·129	25,238*	6,788*	3,446*	92,309	12·266*	3·030*	1·538*	41·209
1,433*	6,176	39°	1·81	1·3	·6	2·16	·022	·010	·012	·049	·026	·023	·103	·072	·031	-	-	-	-	-	-	25,700	90,894	7·157	26,758*	7,944*	6,176*	90,894	11·945*	3·546*	2·757*	40·577
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·172	27,406	8,867*	6,445*	90,659	12·234	3·958*	2·877*	40·472
Vertical - - - -																								7·143	26,029*	7,020*	5,908*	91,130	11·620*	3·133*	2·637*	40·683
Horizontally and Vertically cast - - - Slow - - - - -																								7·144	26,092	8,139	7,133	88,596	11·648	3·633	3·184	39·551
Gradual - - - -																								7·176	27,247	7,843*	6,151*	95,492	12·163	3·501*	2·745*	42·630
Quick - - - -																								7·154	26,682*	7,848*	5,245*	88,596	11·911*	3·503*	2·341*	39·551
Ratio in terms of the Crushing Force - - -																													·294	·087	·007	1·000

MESSRS. PALMER AND BUDD,

No. 3.—FOUNDRY—

MANUFACTURE.

No. 3.—Anthracite Pig Iron, second melting.
Anthracite, or stone coal, from the "Little Vein."
Argillaceous ironstone, known as { Cws-y-glo or Cheese Mine. / Pinmelyn or Yellow Pin.
Hæmatite iron ore from Lancashire.
Limestone used as a flux.

CASTING.

Cast - - 18 September 1856.
Barometer - - - 29·87
Thermometer - - 62·

Weight of—	cwts.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	3	16
Runners - -	0	2	5½
Slag and waste -	0	1	22
Coals consumed -	3	3	12

Time of—	hrs.	min.
Melting - - -	0	40
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D²	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1110			1	7·158	1·3	·000	·002	·004	·008	–	–	–	·009	34,900	26,293	2·04	2·03	8·4066	·055	·005	·125	·015	–	–	·190	13,500	8,029	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1111	Mark $\frac{3}{3}$.	Slow -	2	7·161	1·3	·004	·008	·011	·014	–	–	–	·015	32,000	24,108	2·01	2·06	8·5296	·052	·003	·123	·014	–	–	·192	13,500	7,913	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1112	CAST.		3	7·242	1·3	·004	·008	·009	·011	–	–	–	·013	33,400	25,163	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·	1·	2·	–	–	–	–	–	–	–	–	–	7°·2
1113	18 September 1856.		1	7·161	1·3	·004	·007	·009	·010	–	–	–	·012	32,600	24,560	2·05	1·99	8·1182	·054	·004	·128	·013	–	–	·160	11,600	7,144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1114	TESTED.	Horizontal. Gradual	2	7·164	1·3	·002	·005	·006	·008	–	–	–	·010	33,600	25,314	2·06	2·03	8·4890	·054	·004	·126	·015	–	–	·200	13,700	8,069	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1115	Tensile, 29 May 1857.		3	7·162	1·3	·002	·005	·006	·008	–	–	–	·011	34,800	26,218	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·7	1·5	2·2	–	–	–	–	–	–	–	–	–	8°·
1116	Temp. 65°.		1	7·147	1·3	·003	·005	·007	·008	–	–	–	·010	34,900	26,293	2·01	2·00	8·0400	·057	·005	·130	·015	–	–	·172	12,800	7,960	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1117	Transverse, 31 Jan. 1857.		2	7·139	1·3	·004	·007	·009	·010	–	–	–	·014	34,800	26,218	2·02	2·01	8·1610	·058	·006	·132	·018	–	–	·170	11,900*	7,290*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1118	Temp. 57°.	Quick -	3	7·144	1·3	·002	·005	·008	·010	–	–	–	·013	34,800	26,218	–	–	–	–	–	–	–	–	–	–	–	–	1·795	3·5	1·	2·5	–	–	–	–	–	–	–	–	–	7°·
1119	Torsion, 29 April 1857.		1	7·132	1·3	·003	·007	·010	·014	–	–	–	·015	31,000	23,355	1·98	1·99	7·8409	·052	·008	·150	·027	–	–	·152	10,200	6,504	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1120	Temp. 57°.		2	7·159	1·3	·003	·007	·009	·012	–	–	–	·012	32,000	24,108	1·97	1·97	7·6453	·059	·005	·140	·020	–	–	·182	12,000	7,847	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1121	Crushing, 2 Feb. 1859.	Slow -	3	7·129	1·3	·002	·005	·009	·012	–	–	–	·014	30,500	22,978	–	–	–	–	–	–	–	–	–	–	–	–	1·798	4·	·8	3·2	11·5	5·7	5·8	–	–	–	–	–	–	13°·5
1122	Temp. 56°.		1	7·128	1·3	·000	·003	·005	·008	–	–	–	·009	31,800	23,958	1·98	2·00	7·9200	·060	·005	·141	·020	–	–	·150	10,100	6,376	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1123	FRACTURE.		2	7·126	1·3	·002	·005	·007	·010	–	–	–	·013	31,600	23,807	2·01	2·00	8·0400	·060	·004	–	–	–	–	·140	10,000	6,218	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1124	Light Grey.	Vertical. Gradual	3	7·137	1·3	·004	·008	·011	–	–	–	–	·015	30,000	22,601	–	–	–	–	–	–	–	–	–	–	–	–	1·795	3·5	1·	2·5	–	–	–	–	–	–	–	–	–	10°·5
1125	Bright.		1	7·119	1·3	·003	·006	·010	–	–	–	–	·011	30,000	22,601	2·01	2·01	8·1206	·060	·006	–	–	–	–	·120	10,000*	6,157*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1126	Regular.		2	7·153	1·3	·002	·005	·008	·010	–	–	–	·012	30,900	23,279	–	–	–	–	–	–	–	–	–	–	–	–	1·796	4·	1·3	2·7	–	–	–	–	–	–	–	–	–	7°·
	Medium Grain.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Good working qualities.	Quick -																																							
	GENERAL MEAN - - -			7·150	1·3	·003	·006	·008	·010	–	–	–	·012	32,564	24,533	2·01	2·01	8·1206	·056	·005	·133	·017	–	–	·166	11,754*	7,228*	1·796	3·6	1·1	2·5	11·5	5·7	5·8	–	–	–	–	–	–	8°·8

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 44, at the end.

YSTALYFERA IRON WORKS, SWANSEA.

Second Melting.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·61
Silicon	1·71
Sulphur	0·05
Phosphorus	0·38
Manganese	0·27

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	$\frac{L.}{D.}$ Ratio	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·187	25,188	7,971	5,591*	87,004	11·244	3·558	2·495*	38·839
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,300*	5,591*	38°	1·85	1·3	·6	2·16	·025	·013	·012	·058	·035	·023	-	-	-	-	-	-	-	-	-	24,600	87,004									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·162	25,364	7,606	5,600*	87,711	11·323	3·395	2·500*	39·156
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,300*	5,600*	40°	1·82	1·3	·6	2·16	·019	·008	·011	·053	·033	·020	-	-	-	-	-	-	-	-	-	24,800	87,711									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·143	26,243	7,625*	5,187*	97,614	11·715	3·404*	2·315*	43·577
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200*	5,187*	42°	1·38	1·3	·6	2·16	·022	·008	·014	·045	·024	·021	·090	·059	·031	-	-	-	-	-	-	27,600	97,614									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·140	23,480	7,175	6,494	84,175	10·482	3·203	2·899	37·578
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,510	6,494	41°	2·19	1·3	·6	2·16	·027	·013	·014	·059	·035	·024	-	-	-	-	-	-	-	-	-	23,800	84,175									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·130	23,455	6,297	6,051	87,358	10·470	2·811	2·701	38·995
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,400	6,051	36°	1·90	1·3	·6	2·16	·018	·007	·011	·050	·018	·032	-	-	-	-	-	-	-	-	-	24,700	87,358									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·136	22,940	6,157*	5,394*	- -	10·241	2·748*	2·408*	—
1,250*	5,394*	35°	1·56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,326*	5,719*	37°	1·78	1·3	·6	2·16	·022	·010	·012	·053	·029	·024	·090	·059	·031	-	-	-	-	-	-	25,100	88,772	7·150	24,533	7,228*	5,719*	88,772	10·952	3·226*	2·553*	39·629
																								7·164	25,598	7,734*	5,459*	90,743	11·427	3·452*	2·437*	40·510
																								7·135	23,336	6,620*	5,979*	85,767	10·417	2·955*	2·669*	38·285
																								7·164	24,334	7,573	6,042*	85,590	10·863	3·380	2·697*	38·209
																								7·146	24,409	6,951	5,825*	87,535	10·892	3·103	2·600*	39·078
																								7·140	24,591	6,891*	5,290*	97,614	10·978	3·076	2·361*	43·577
																													·276	·081	·064	1·000

Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -
Vertical - - - -
Horizontally and Vertically cast - - - Slow - - - - -
Gradual - - - -
Quick - - - -
Ratio in terms of the Crushing Force - - -

MESSRS. PALMER AND BUDD,

No. 1.—FOUNDRY—

MANUFACTURE.

No. 1.—Anthracite Pig Iron, first melting, smelted and manufactured from the following materials:—
Anthracite, or stone coal, from the "Little Vein."
Argillaceous ironstone, known as { Cws-y-glo or Cheese Mine. / Pinmelyn or Yellow Pin.
Hæmatite iron ore from Lancashire.
Limestone used as a flux.

CASTING.

Cast	18 September 1856.
Barometer	29·87
Thermometer	62·

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	3	2	8
Runners	0	1	27
Slag and waste	0	0	0
Coals consumed	3	1	14

Time of—	hrs.	min.
Melting	0	35
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1127	Mark $\frac{3}{4}$.	Horizontal. Slow	1	7·161	1·3	·003	·007	·009	·011	·014	–	–	·015	37,000	27,875
1128			2	6·991	1·3	·003	·005	·009	·011	–	–	–	·013	34,000*	25,615*
1129	CAST. 18 September 1856.		3	7·162	1·3	·002	·005	·008	·011	·014	–	–	·017	36,200	27,273
1130		Horizontal. Gradual	1	7·164	1·3	·003	·006	·008	·010	·012	–	–	·012	35,000	26,409
1131	TESTED. Tensile, 29 May 1857. Temp. 65°.		2	7·175	1·3	·003	·005	·007	·009	·010	–	–	·011	36,000	27,122
1132			3	7·191	1·3	·000	·003	·006	·010	–	–	–	·012	33,800	25,465
1133	Transverse, 1 April 1857.	Horizontal. Quick	1	7·182	1·3	·003	·006	·009	·011	–	–	–	·012	34,000	25,615
1134	Temp. 60°.		2	7·118	1·3	·002	·005	·007	·009	–	–	–	·012	34,900	26,293
1135	Torsion, 29 April 1857. Temp. 57°.		3	7·182	1·3	·003	·005	·008	·010	·011	–	–	·012	35,200	26,519
1136		Vertical. Slow	1	7·174	1·3	·002	·005	·007	·010	–	–	–	·013	34,500	25,992
1137	Crushing, 2 Feb. 1859. Temp. 56°.		2	7·152	1·3	·004	·008	·012	·014	–	–	–	·015	31,000	23,355
1138			3	7·156	1·3	·003	·005	·008	·010	–	–	–	·012	32,100	24,183
1139	FRACTURE. Dark Grey.	Vertical. Gradual	1	7·157	1·3	·002	·005	·008	·011	–	–	–	·012	31,000	23,355
1140	Dull.		2	7·133	1·3	·003	·006	·008	·011	–	–	–	·012	31,900	24,033
1141	Regular. Medium Grain.		3	7·164	1·3	·002	·005	·009	·011	–	–	–	·013	33,900	25,540
1142	Good working qualities.	Vertical. Quick	1	6·854	1·3	·003	·007	·010	–	–	–	–	·011	27,000*	20,341*
1143			2	–	–	–	–	–	–	–	–	–	–	–	–
			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			7·132	1·3	·002	·005	·008	·011	·012	–	–	·013	33,594*	25,311*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1127	2·04	2·07	8·7411	·053	·004	·125	·010	–	–	·143	11,000*	6,292*	–	–	–	–	–	–	–	–	–	–	–	–	–
1128	2·04	1·96	7·8368	·055	·003	·133	·019	–	–	·176	12,300	7,847	–	–	–	–	–	–	–	–	–	–	–	–	–
1129	–	–	–	–	–	–	–	–	–	–	–	–	1·798	–	–	–	–	–	–	–	–	–	–	–	–	5°·
1130	2·04	2·04	8·4896	·048	·001	·121	·013	·238	·055	·239	15,000	8,834	–	–	–	–	–	–	–	–	–	–	–	–	–
1131	2·02	2·00	8·0800	·052	·003	·118	·011	–	–	·208	14,500	8,972	–	–	–	–	–	–	–	–	–	–	–	–	–
1132	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·5	1·	2·5	10·2	6·5	3·7	–	–	–	–	–	14°·5
1133	2·05	2·02	8·3648	·052	·002	·125	·016	–	–	·238	14,900	8,906	–	–	–	–	–	–	–	–	–	–	–	–	–
1134	2·03	2·05	8·5310	·050	·004	·120	·016	–	–	·192	14,000	8,205	–	–	–	–	–	–	–	–	–	–	–	–	–
1135	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·5	1·3	2·2	13·5	7·	6·5	–	–	–	–	–	24°·
1136	2·01	2·02	8·2016	·051	·002	·125	·015	–	–	·159	12,000*	7,315*	–	–	–	–	–	–	–	–	–	–	–	–	–
1137	2·04	2·03	8·4066	·051	·001	–	–	–	–	·133	10,000*	5,947*	–	–	–	–	–	–	–	–	–	–	–	–	–
1138	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·7	·0	2·7	–	–	–	–	–	–	–	–	10°·5
1139	1·97	1·98	7·7231	·056	·003	·131	·018	–	–	·142	14,000*	9,063*	–	–	–	–	–	–	–	–	–	–	–	–	–
1140	2·00	1·99	7·9202	·052	·004	·134	·017	–	–	·134	10,000*	6,312*	–	–	–	–	–	–	–	–	–	–	–	–	–
1141	–	–	–	–	–	–	–	–	–	–	–	–	1·798	3·5	·5	3·	–	–	–	–	–	–	–	–	8°·
1142	1·99	2·01	8·0397	·056	·004	·135	·019	–	–	·152	10,500*	6,530*	–	–	–	–	–	–	–	–	–	–	–	–	–
1143	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2·02	2·01	8·1610	·052	·003	·127	·015	·238	·055	·174	12,564*	7,656*	1·798	3·3	·7	2·6	11·8	6·7	5·1	–	–	–	–	–	12°·4

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 45, at the end.

YSTALYFERA IRON WORKS, SWANSEA.

First Melting.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·17
Silicon	1·58
Sulphur	0·05
Phosphorus	0·42
Manganese	0·32

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·104	26,021*	7,069*	4,085*	80,991	12·018*	3·137*	1·823*	36·156
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22,000	80,991									
950*	4,085*	35°	1·56	1·3	·6	2·16	·045	·032	·013	·060	·045	·015	-	-	-	-	-	-	-	-	-										
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·176	26,332	8,903	6,998	91,955	11·755	3·974	3·124	41·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,630	6,998	38°	2·00	1·3	·6	2·16	·022	·011	·011	·052	·031	·021	·122	·000	·032	-	-	-	-	-	-	26,000	91,955									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·160	26,142	8,555	7,814	88,065	11·670	3·819	3·488	39·312
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,820	7,814	39°	1·95	1·3	·6	2·16	·027	·012	·015	·056	·034	·022	-	-	-	-	-	-	-	-	-	24,900	88,065									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·160	24,510	6,631*	6,408	84,882	10·941	2·960*	2·860	37·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,490	6,408	39°	1·34	1·3	·6	2·16	·024	·010	·014	·052	·030	·022	-	-	-	-	-	-	-	-	-	24,000	84,882									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·151	24,309	7,687*	6,021*	91,955	10·852	3·431*	2·687*	41·051
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,400*	6,021*	33°	1·76	1·3	·6	2·16	·015	·003	·012	·040	·020	·020	·141	·083	·058	-	-	-	-	-	-	26,000	91,955									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·854	20,341*	6,530	- -	- -	9·080*	2·915	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,458	6,265	37°	1·72	1·3	·6	2·16	·027	·014	·013	·052	·032	·020	·132	·087	·045	-	-	-	-	-	-	24,760	87,570	7·132	25,311*	7,656*	6,265*	87,570	11·299*	3·417*	2·796*	39·093
Combined Means - - - Slow, Gradual, and Quick cooling - - - Horizontal - - -																							7·147	26,465*	8,176*	6,299*	87,004	11·814*	3·650*	2·812*	38·839
Vertical - - - -																							7·112	23,828*	7,033*	6,214*	87,919	10·637*	3·139*	2·774*	39·245
Horizontally and Vertically cast - - - Slow - - - - -																							7·132	25,715*	6,850*	5,246*	82,937	11·479*	3·058*	2·341*	37·025
Gradual - - - -																							7·164	25,320	8,295*	6,509*	91,955	11·303	3·703*	2·905*	41·051
Quick - - - -																							7·007	23,241*	7,542*	7,814	88,065	10·375*	3·366*	3·488	39·312
Ratio in terms of the Crushing Force - - -																												·289	·087	·071	1·000

MESSRS. PALMER AND BUDD,

No. 2.—FOUNDRY,

MANUFACTURE.

No. 2.—Anthracite Pig Iron, first melting:—
Stone, or anthracite coal, from the "Little Vein."
Argillaceous ironstone, known as { Cws-y-glo or Cheese Mine. / Pinmelyn or Yellow Pin.
Hæmatite iron ore from Lancashire.
Limestone used as a flux.

CASTING.

Cast - - 25 September 1856.
Barometer - - - 29·62
Thermometer - - 64·

Weight of—	cwts.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	4	0	14
Runners - -	0	2	8
Slag and waste	0	2	15
Coals consumed	4	1	14

Time of—	hrs.	min.
Melting - - -	0	35
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1144			1	7·150	1·3	·003	·007	·010	·014	–	–	–	·015	30,100	22,676
1145	Mark $\frac{3}{5}$.	Slow -	2	7·147	1·3	·003	·006	·009	·010	–	–	–	·010	30,000	22,601
1146			3	7·142	1·3	·003	·005	·009	·011	–	–	–	·011	30,000	22,601
	CAST.														
1147	26 September 1856.	Horizontal.	1	7·132	1·3	·002	·005	·008	–	–	–	–	·009	29,400	22,149
1148		Gradual	2	7·129	1·3	·004	·009	·013	–	–	–	–	·016	29,000	21,848
1149	TESTED.		3	7·139	1·3	·002	·006	·009	–	–	–	–	·010	29,100	21,923
	Tensile, 30 May 1857.														
	Temp. 62°.														
1150			1	7·147	1·3	·003	·007	·010	·013	–	–	–	·014	31,500	23,732
1151	Transverse, 2 April 1857.	Quick -	2	7·151	1·298	·004	·008	·012	·015	–	–	–	·015	30,000	22,671
1152	Temp. 55°.		3	7·162	1·3	·003	·007	·011	–	–	–	–	·013	29,000	21,848
	Torsion, 1 May 1857.														
	Temp. 59°.														
1153			1	7·076	1·297	·004	·008	·012	–	–	–	–	·015	26,100	19,754
1154	Crushing, 3 Feb. 1859.	Slow -	2	7·106	1·292	·002	·007	·011	–	–	–	–	·012	26,000	19,831
1155	Temp. 54°.		3	7·154	1·3	·003	·008	·011	–	–	–	–	·012	27,600	20,793
	FRACTURE.														
1156	Medium Grey.	Vertical.	1	7·123	1·3	·004	·008	·011	–	–	–	–	·013	26,700	20,115
1157	Bright.	Gradual	2	7·106	1·299	·004	·008	·011	–	–	–	–	·012	27,500	20,750
1158	Regular.		3	7·153	1·3	·003	·007	·012	–	–	–	–	·013	25,500	19,211
	Medium Grain.														
1159	Good working qualities.		1	7·102	1·3	·002	·006	·009	–	–	–	–	·010	29,900	22,745
1160		Quick -	2	7·126	1·292	·003	·006	·010	–	–	–	–	·011	29,900	22,806
1161			3	7·138	1·3	·003	·006	·009	–	–	–	–	·011	29,000	21,848
	GENERAL MEAN - - -			7·132	1·298	·003	·007	·010	·012	–	–	–	·012	28,683	21,661

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1144	2·01	2·02	8·2016	·051	·005	·139	·025	–	–	·200	13,500	8,230
1145	2·02	2·03	8·3642	·051	·009	·136	·028	–	–	·190	12,700	7,628
1146	–	–	–	–	–	–	–	–	–	–	–	–
1147	2·02	2·02	8·2420	·057	·002	·133	·016	–	–	·188	12,500*	7,582*
1148	1·98	1·99	7·8409	·056	·003	·136	·016	–	–	·189	12,300	7,843
1149	–	–	–	–	–	–	–	–	–	–	–	–
1150	2·02	2·05	8·4890	·059	·005	·130	·015	–	–	·221	14,600	8,599
1151	2 01	1·98	7·8800	·059	·003	·135	·012	–	–	·188	12,700	8,058
1152	–	–	–	–	–	–	–	–	–	–	–	–
1153	2·05	2·00	8·2000	·051	·006	·152	·025	–	–	·156	10,600	6,463
1154	2·05	2·01	8·2822	·056	·004	–	–	–	–	·130	9,500	5,735
1155	–	–	–	–	–	–	–	–	–	–	–	–
1156	1·97	2·00	7·8800	·052	·010	–	–	–	–	·140	8,700	5,520
1157	1·99	1·98	7·8015	·053	·008	·154	·024	–	–	·182	11,300	7,242
1158	–	–	–	–	–	–	–	–	–	–	–	–
1159	1·98	2·00	7·9200	·053	·005	·141	·020	–	–	·165	11,200	7,070
1160	1·98	1·98	7·7623	·060	·005	·145	·014	–	–	·150	10,100	6,505
1161	–	–	–	–	–	–	–	–	–	–	–	–
	2·00	2·00	8·0000	·055	·005	·140	·020	–	–	·175	11,641*	7,206*

Register No.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1144	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1145	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1146	1·8	5·	1·	4·	12·	6·3	5·7	–	–	–	–	–	–	14°·
1147	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1148	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1149	1·799	4·	·5	3·5	13·5	7·7	5·8	–	–	–	–	–	–	15°·
1150	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1151	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1152	1·799	2·7	·0	2·7	9·5	4·3	5·2	–	–	–	–	–	–	16°·5
1153	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1154	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1155	1·795	5·	1·3	3·7	–	–	–	–	–	–	–	–	–	13°·
1156	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1157	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1158	1·796	4·5	1·	3·5	–	–	–	–	–	–	–	–	–	7°·5
1159	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1160	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1161	1·794	3·2	·0	3·2	–	–	–	–	–	–	–	–	–	7°·
	1·797	4·	·6	3·4	11·6	6·1	5·5	–	–	–	–	–	–	12°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 46, at the end.

YSTALYFERA IRON WORKS, SWANSEA.

First Melting.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·55
Silicon	2·07
Sulphur	0·09
Phosphorus	0·38
Manganese	0·14

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,560	6,687	30°	1·50	1·3	·6	2·16	·029	·013	·016	·067	·043	·024	-	-	-	-	-	-	-	-	-	21,500	76,040	7·146	22,626	7,929	6,687	76,040	10·100	3·539	2·985	33·946
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,530	6,569	36°	2·10	1·3	·6	2·16	·027	·015	·012	·068	·048	·020	-	-	-	-	-	-	-	-	-	22,000	77,808	7·133	21,973	7,712*	6,569	77,808	9·809	3·442*	2·932	34·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,720	7,385	35°	1·80	1·3	·6	2·16	·023	·009	·014	·051	·030	·021	-	-	-	-	-	-	-	-	-	23,300	82,406	7·153	22,750	8,328	7,385	82,406	10·156	3·717	3·296	36·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,480	6,397	35°	1·64	1·3	·6	2·16	·026	·013	·013	·066	·043	·023	-	-	-	-	-	-	-	-	-	21,000	74,272	7·112	20,126	6,099	6,397	74,272	8·984	2·722	2·855	33·157
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,450*	6,257*	38°	1·80	1·3	·6	2·16	·018	·000	·018	·072	·040	·032	-	-	-	-	-	-	-	-	-	21,000	74,272	7·127	20,025	6,381	6,257*	74,272	8·939	2·848	2·793*	33·157
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,400*	6,061*	44°	1·86	1·3	·6	2·16	·025	·009	·016	·055	·031	·024	-	-	-	-	-	-	-	-	-	22,800	80,638	7·122	22,466	6,787	6,061*	80,638	10·030	3·029	2·705*	35·999
1,523*	6,559*	36°	1·78	1·3	·6	2·16	·028	·010	·018	·063	·039	·024	-	-	-	-	-	-	-	-	-	21,933	77,573	7·132	21,661	7,206*	6,559*	77,573	9·670	3·216*	2·928*	34·630
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·144	22,450	7,990*	6,880	78,751	10·022	3·566*	3·071	35·156
Combined Means - - - Slow, Gradual and Quick cooling - - - Vertical - - -																								7·120	20,872	6,422	6,238*	76,394	9·317	2·867	2·784*	34·104
Combined Means - - - Horizontally and Vertically cast - - - Slow - - - - -																								7·129	21,376	7,014	6,542	75,156	9·542	3·131	2·920	33·551
Combined Means - - - Horizontally and Vertically cast - - - Gradual - - - -																								7·130	20,999	7,046*	6,413*	76,040	9·374	3·145*	2·862*	33·946
Combined Means - - - Horizontally and Vertically cast - - - Quick - - - -																								7·138	22,608	7,557	6,723*	81,522	10·092	3·373	3·001*	36 392
Ratio in terms of the Crushing Force - - -																													·279	·092	·084	1·000

MESSRS. PALMER AND BUDD,

No. 3.—FOUNDRY,

MANUFACTURE.

No. 3.—Anthracite Pig Iron, first melting :—

Stone, or anthracite coal, from the "Little Vein."
Argillaceous ironstone, known as { Cws-y-glo or Cheese Mine. / Pinmelyn or Yellow Pin.
Hæmatite iron ore, from Lancashire.
Limestone used as a flux.

CASTING.

Cast	26 September 1856.
Barometer	29·62
Thermometer	64·

Weight of—	*cwt.*	*qrs.*	*lbs.*
Charge	5	0	0
Castings	4	0	16
Runners	0	2	7
Slag and Waste	0	1	27
Coals consumed	3	1	6

Time of—	*hrs.*	*min.*
Melting	0	35
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

CHEMICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1162	Mark $\frac{3}{6}$.	Horizontal. Slow	1	7·166	1·3	·003	·007	·008	·009	–	–	–	·009	30,000	22,601
1163	CAST.		2	7·170	1·3	·005	·008	·011	·015	–	–	–	·016	31,200	23,506
1164	26 September 1856.		3	7·146	1·3	·004	·007	·010	·012	–	–	–	·013	30,100	22,676
1165	TESTED.	Horizontal. Gradual	1	7·147	1·3	·003	·005	·007	·009	–	–	–	·011	30,000	22,601
1166	Tensile, 3 June 1857.		2	7·146	1·3	·003	·005	·008	·010	–	–	–	·011	32,900	24,786
1167	Temp. 65°.		3	7·147	1·3	·002	·005	·008	·011	–	–	–	·012	31,700	23,882
1168	Transverse, 3 April 1857.	Horizontal. Quick	1	7·159	1·3	·001	·004	·005	·007	–	–	–	·008	33,300	25,088
1169	Temp. 60°.		2	7·171	1·3	·009	·011	·012	·015	–	–	–	·016	34,400	25,916
1170	Torsion, 2 May 1857.		3	7·110	1·3	·003	·006	·008	·009	–	–	–	·010	33,200	25,013
1171	Temp. 57°.	Vertical. Slow	1	7·140	1·3	·002	·005	·008	–	–	–	–	·009	27,000	20,341
1172	Crushing, 2 Feb. 1859.		2	7·165	1·3	·003	·007	·008	–	–	–	–	·010	28,900	21,773
1173	Temp. 54°.		3	7·157	1·3	·002	·004	·006	–	–	–	–	·009	27,000	20,341
1174	FRACTURE.	Vertical. Gradual	1	7·147	1·295	·001	·004	·007	·009	–	–	–	·010	34,800	26,420
1175	Light Grey.		2	7·141	1·293	·002	·006	·010	·012	–	–	–	·013	34,000	25,803
1176	Bright.		3	7·161	1·3	·000	·003	·006	·008	–	–	–	·009	32,000	24,108
1177	Regular.	Vertical. Quick	1	7·166	1·3	·002	·005	·006	·010	–	–	–	·011	32,700	24,635
1178	Medium Grain.		2	7·168	1·3	·001	·004	·007	·009	–	–	–	·012	33,600	25,314
1179	Good working qualities.		3	7·161	1·3	·001	·005	·007	–	–	–	–	·009	29,000	21,848
	GENERAL MEAN			7·153	1·299	·002	·006	·008	·010	–	–	–	·012	31,433	23,707

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1162	2·05	1·99	8·1182	·063	·008	·149	·022	–	–	·208	13,200	8,129
1163	2·01	1·98	7·8800	·052	·003	·128	·020	–	–	·237	14,000	8,883
1164	–	–	–	–	–	–	–	–	–	–	–	–
1165	2·00	2·01	8·0802	·055	·004	·127	·020	–	–	·230	13,800	8,539
1166	2·04	2·02	8·3240	·051	·003	·125	·020	–	–	·217	13,700	8,229
1167	–	–	–	–	–	–	–	–	–	–	–	–
1168	1·99	2·00	7·9600	·050	·005	·124	·015	–	–	·210	14,000	8,793
1169	2·01	2·00	8·0400	·049	·000	·120	·012	–	–	·200	14,100	8,768
1170	–	–	–	–	–	–	–	–	–	–	–	–
1171	2·01	2·04	8·3648	·054	·001	·138	·020	–	–	·150	10,900	6,515
1172	2·02	2·04	8·4064	·050	·000	·136	·016	–	–	·137	10,000	5,947
1173	–	–	–	–	–	–	–	–	–	–	–	–
1174	1·96	1·97	7·6065	·055	·005	·148	·025	–	–	·161	10,300	6,770
1175	1·98	1·98	7·7623	·058	·006	·148	·026	–	–	·188	11,500	7,407
1176	–	–	–	–	–	–	–	–	–	–	–	–
1177	2·00	2·00	8·0000	·056	·006	·124	·010	–	–	·152	12,300	7,687
1178	2·03	2·04	8·4480	·051	·002	·120	·012	–	–	·174	13,100	7,753
1179	–	–	–	–	–	–	–	–	–	–	–	–
	2·00	2·00	8·0000	·054	·004	·132	·018	–	–	·188	12,575	7,785

TORSION. Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar.

Register No.	Diameter.	1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1162	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1163	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1164	1·799	3·5	·5	3·	–	–	–	–	–	–	–	–	–	8°·2
1165	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1166	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1167	1·8	3·	·5	2·5	10·5	6·	4·5	–	–	–	–	–	–	20°·
1168	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1169	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1170	1·797	2·3	·3	2·	7·	3·5	3·5	–	–	–	–	–	–	9°·
1171	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1172	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1173	1·8	4·7	·7	4·	–	–	–	–	–	–	–	–	–	9°·
1174	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1175	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1176	1·8	4·	1·	3·	13·	8·	5·	–	–	–	–	–	–	22°·
1177	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1178	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1179	1·8	3·3	·8	2·5	8·3	4·	4·3	–	–	–	–	–	–	11°·5
	1·799	3·4	·6	2·8	9·7	5·4	4·3	–	–	–	–	–	–	13°·3

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 47, at the end.

YSTALYFERA IRON WORKS, SWANSEA.

First Melting.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·16
Silicon	1·55
Sulphur	0·06
Phosphorus	0·27
Manganese	0·43

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,450	6,226	35°	1·53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·160	22,927	8,506	6,226	- -	10·233	3·797	2·779	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,790	7,673	40°	2·19	1·3	·6	2·16	·012	·008	·004	·035	·025	·010	·093	·082	·011	-	-	-	-	-	-	25,200	89,126	7·146	23,756	8,384	7,673	89,126	10·605	3·742	3·425	39·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,550	6,677	36°	1·76	1·3	·6	2·16	·021	·010	·011	·046	·025	·021	·096	·066	·030	-	-	-	-	-	-	25,500	90,187	7·146	25,339	8,780	6,677	90,187	11·312	3·919	2·980	40·262
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,470	6,301	35°	1·79	1·3	·6	2·16	·035	·020	·015	-	-	-	-	-	-	-	-	-	-	-	-	19,900	70,381	7·154	20,818	6,231	6,301	70,381	9·293	2·781	2·812	31·420
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,740	7,458	45°	2·01	1·3	·6	2·16	·028	·015	·013	·058	·036	·022	-	-	-	-	-	-	-	-	-	23,900	84,528	7·149	25,473	7,088	7,458	84,528	11·371	3·164	3·329	37·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,640	7,030	35°	1·55	1·3	·6	2·16	·021	·008	·013	·045	·023	·022	·095	·062	·033	-	-	-	-	-	-	25,800	91,248	7·165	23,932	7,720	7,030	91,248	10·683	3·446	3·138	40·735
1,606	6,894	38°	1·80	1·3	·6	2·16	·023	·012	·011	·046	·027	·019	·095	·070	·025	-	-	-	-	-	-	24,060	85,094	7·153	23,707	7,785	6,894	85,094	10·583	3·475	3·077	37·988
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·151	24,007	8,556	6,858	89,657	10·717	3·819	3·061	40·025
Vertical - - - -																								7·156	23,408	7,013	6,929	82,052	10·450	3·130	3·093	36·630
Horizontally and Vertically cast - - - Slow - - - - -																								7·157	21,872	7,368	6,263	70,381	9·764	3·289	2·795	31·420
Gradual - - - -																								7·148	24,614	7,736	7,565	86,827	10·988	3·453	3·377	38·758
Quick - - - -																								7·156	24,635	8,250	6,853	90,718	10·997	3·683	3·059	40·499
Ratio in terms of the Crushing Force - - -																													·278	·091	·081	1·000

YSTALYFERA IRON WORKS, NEAR SWANSEA.

(Mr. G. Palmer Budd.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores used in the Production of Ystalyfera Iron are—

I. Clay ironstone, from "Cheese" Mine.

II. Clay ironstone, from "Yellow" Mine.

III. Hæmatite, Ulverston.

Of these, a sample of doubtful identity, having no label attached, accompanied the first and third mentioned ores, but was not submitted to analysis.

I. *Ore, from Cheese Mine, Ystalyfera.*—The sample from which an average was selected for analysis, consisted of a nodule of clay-ironstone, dark grey in colour, and intersected by numerous veins of calcareous iron-spar, in which a few crystals of quartz were discovered.

Protoxide of iron	42·72
Oxide of manganese	0·46
Lime	4·66
Magnesia	5·73
Carbonic acid	35·70
Phosphoric acid	0·49
Bisulphide of iron Silica, as quartz	*traces.*
Water, hygroscopic	0·26
Water in combination	1·54
Organic matter	0·30
Clay, ignited	8·23
	100·09
Metallic iron	33·45

III. *Hæmatite Ore, Ulverston.*—The sample of ore forwarded under this name was a selected specimen of kidney hæmatite. It was found on analysis to be nearly pure *peroxide of iron*, the only impurities consisting of a little *oxide of manganese* and *silicious matter*, insoluble in hydrochloric acid. It contained no sulphur, and only a minute trace of *phosphoric acid.*

Fuel.

Anthracite.—An average sample was found to contain—

Sulphur - - - - - - - - 0·70 per cent.

and left on burning,

Ash - - - - - - - - 9·14 per cent.

The white ash consisted of *silicate of alumina*, with a small quantity of *lime*, and a trace of *peroxide of iron.*

YSTALYFERA IRON WORKS, NEAR SWANSEA—*continued.*

FLUX.

Limestone, light coloured, crystalline.

(Sample dried at 212° Fahrenheit.)

Carbonate of lime	99·49
Carbonate of iron	0·18
Carbonate of manganese	0·07
Phosphate of lime, Alumina, Carbonaceous matter	*traces.*
Silica (grains of sand)	0·26
	100·00

No traces of magnesia, sulphates, nor of heavy metals, were discoverable in a large quantity of the limestone.

IRONS.

I., II. and III. Anthracite pig iron, Nos. 1, 2 and 3 (second melting).

IV., V. and VI. Anthracite pig iron, Nos. 1, 2 and 3 (first melting).

Important Constituents in 100 *parts.*

	I.	II.	III.	IV.	V.	VI.
Carbon, as graphite	3·27	2·92	2·61	3·17	2·55	3·16
Silicon	1·87	1·73	1·71	1·58	2·07	1·55
Sulphur	0·05	0·06	0·05	0 05	0·09	0·06
Phosphorus	0·41	0·29	0·38	0·42	0·38	0·27
Manganese	0·27	0·39	0·27	0·32	0·14	0·43

MESSRS. THOMAS, BLAENAVON

No. 1 and

MANUFACTURE.

No. 1 and C Forge.—Pig Iron, manufactured from the following ingredients; viz.:—
Three-quarter coal and old coal coke.
Rough and smooth limestone in raw state.
Black Pin—Pwll Llacca—Ball Mine } calcined.
Bottom Vein—Grey Vein } calcined.
Smelted entirely by cold blast.

CASTING.

Cast - - - 7 October 1856.
Barometer - - - 29·95
Thermometer - - - 67°

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	1	8
Runners - -	0	2	4
Slag and waste -	0	2	23
Coals consumed -	4	3	13

Time of—	hrs.	min.
Melting - - -	0	58
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting - -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1612	Mark $\frac{14}{1}$.	Horizontal. Slow -	1	7·222	1·3	·000	·002	·003	·005	·008	–	–	·012	38,000	28,628
1613			2	7·221	1·3	·001	·003	·005	·007	·010	–	–	·012	36,200	27,273
1614	CAST.		3	7·239	1·3	·000	·002	·005	·007	·010	–	–	·012	35,500	26,745
	7 October 1856.														
1615			1	7·233	1·3	·001	·003	·005	·007	·010	·014	–	·015	40,600	30,587
1616	TESTED.	Gradual	2	7·238	1·3	·002	·004	·006	·008	–	–	–	·010	34,500	25,992
1617	Tensile, 9 Dec. 1857.		3	7·242	1·3	·002	·005	·008	·009	–	–	–	·014	34,900	26,293
	Temp. 58°.														
1618			1	7·230	1·3	·002	·004	·006	·008	·012	–	–	·013	37,300	28,101
	Transverse, 6 Oct. 1857.														
1619	Temp. 58°.	Quick -	2	7·213	1·3	·001	·003	·005	·007	·009	–	–	·011	36,900	27,800
1620			3	7·238	1·3	·000	·002	·005	·007	·009	–	–	·011	37,000	27,875
	Torsion, 21 Oct. 1857.														
	Temp. 60°.														
1621			1	–	–	–	–	–	–	–	–	–	–	–	–
1622	Crushing, 2 Feb. 1859.	Slow -	2	7·113	1·3	·000	·003	·005	·008	–	–	–	·009	31,000*	23,355*
1623	Temp. 54°.		3	6·503	1·3	·000	·002	·003	·005	–	–	–	·005	30,000*	22,661*
	FRACTURE.														
1624	Medium Dull Grey.	Vertical.	1	7·203	1·3	·000	·003	·005	·008	·011	–	–	·014	37,700	28,402
1625	Bluish.	Gradual	2	7·188	1·3	·001	·003	·006	·008	–	–	–	·012	31,000*	23,355*
1626	Regular.		3	7·211	1·3	·002	·004	·006	·008	·009	–	–	·011	36,800	27,725
	Fine Grain.														
1627	Good working quality.		1	–	–	–	–	–	–	–	–	–	–	–	–
1628		Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–
1629			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN - -			7·163	1·3	·001	·003	·005	·007	·010	·014	–	·011	35,528*	26,766*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1612	2·00	2·04	8·3232	·054	·005	·132	·015	·205	·054	·216	15,200	9,131
1613	2·06	1·96	7·9487	·060	·004	·139	·020	–	–	·200	14,000*	8,845*
1614	–	–	–	–	–	–	–	–	–	–	–	–
1615	2·04	1·96	7·8368	·051	·005	·125	·017	–	–	·178	13,000*	8,294*
1616	2·03	1·99	8·0390	·063	·008	·124	·020	–	–	·173	13,500*	8,396*
1617	–	–	–	–	–	–	–	–	–	–	–	–
1618	2·00	1·97	7·7618	·059	·008	·123	·020	–	–	·208	14,500	9,340
1619	2·01	1·98	7·8800	·055	·005	·120	·018	–	–	·211	13,500	8,565
1620	–	–	–	–	–	–	–	–	–	–	–	–
1621	1·98	2·08	8·5662	·054	·009	–	–	–	–	·180	9,500*	5,459*
1622	1·98	2·00	7·9200	·055	·003	·123	·012	–	–	·147	11,000*	6,944*
1623	–	–	–	–	–	–	–	–	–	–	–	–
1624	1·99	2·02	8·1199	·053	·004	·115	·013	–	–	·174	13,100	8,067
1625	2·00	2·02	8·4872	·055	·003	·120	·015	–	–	·136	10,500*	6,433*
1626	–	–	–	–	–	–	–	–	–	–	–	–
1627	–	–	–	–	–	–	–	–	–	–	–	–
1628	–	–	–	–	–	–	–	–	–	–	–	–
1629	–	–	–	–	–	–	–	–	–	–	–	–
	2·01	2·00	8·0400	·055	·005	·124	·016	·205	·054	·182	12,780*	7,947*

Register No.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1612	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1613	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1614	1·796	3·1	1·	2·1	–	–	–	–	–	–	–	–	–	6°·
1615	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1616	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1617	1·796	2·1	·2	1·9	–	–	–	–	–	–	–	–	–	5°·5
1618	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1619	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1620	1·798	2·1	·1	2·	–	–	–	–	–	–	–	–	–	8°·9
1621	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1622	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1623	1·794	2·4	·5	1·9	–	–	–	–	–	–	–	–	–	3°·4
1624	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1625	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1626	1·796	1·5	·0	1·5	–	–	–	–	–	–	–	–	–	6°·7
1627	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1628	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1629	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1·796	2·2	·3	1·9	–	–	–	–	–	–	–	–	–	6°·1

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 48, at the end.

IRON WORKS, MONMOUTHSHIRE.

C. FORGE.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·82
Silicon	0·81
Sulphur	0·06
Phosphorus	0·38
Manganese	0·53

TEST.

TORSION.				CRUSHING.																	TORSION.		CRUSHING.		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.		Breaking Weight.											
							15,000 lbs.			20,000 lbs			25,000 lbs.			30,000 lbs.			35,000 lbs.															
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio L. D.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
1,250*	5,394*	30°	1·88	1·3	·6	2·16	·021	·009	·012	·045	·021	·024	·075	·047	·028	-	-	-	-	-	-	29,900	105,749	- -	- -	7·227	27,548	8,988*	5,394*	105,749	12·295	4·012*	2·408*	47·254
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
1,260*	5,437*	34°	1·51	1·3	·6	2·16	·023	·013	·010	·047	·029	·018	·078	·052	·026	·145	·111	·034	-	-	-	31,300	110,700	- -	- -	7·237	27,624	8,345*	5,437*	110,700	12·332	3·725*	2·427*	49·419
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
1,440	6,193	33°	2·09	1·3	·6	2·16	·022	·010	·012	·045	·024	·021	·079	·050	·029	-	-	-	-	-	-	28,800	101,858	- -	- -	7·227	27,925	8,952	6,193	101,858	12·466	3·996	2·764	45·472
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
1,010*	4,373*	32°	1·45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	6·808*	22,078*	6,201*	4,373*	- -	10·254*	2·768*	1·952*	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
1,400	6,041	35°	1·70	1·3	·6	2·16	·022	·015	·007	·050	·031	·019	·086	·060	·026	-	-	-	-	-	-	29,000	102,566	- -	- -	7·200	26,494*	7,250*	6,041	102,566	11·827*	3·236*	2·696	45·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-									
1,272*	5,487*	33°	1·72	1·3	·6	2·16	·022	·012	·010	·047	·026	·021	·080	·055	·025	-	-	-	-	-	-	29,750	105,203	7·163*	26,766*	7,947*	5,487*	105,203	11·949*	3·547*	2·449*	46·965
Combined Means - - -																								Slow, Gradual, and Quick cooling - -										
																								Horizontal - - -		7·230	27,699	8,762*	5,674*	106,102	12·365	3·511*	2·533*	47·366
																								Vertical - - - -		7·043*	25,087*	6,725*	5,207*	102,566	11·199*	3·002*	2·324*	45·788
																								Horizontally and Vertically cast - -	Slow - - - - -	7·018*	25,263*	7,594*	4,883*	105,749	11·278*	3·390*	2·179*	47·254
																									Gradual - - - -	7·219	27,059*	7,797*	5,739*	106,633	12·079*	3·480*	2·562*	47·604
																									Quick - - - -	7·227	27,925	8,952	6,193	101,858	12·466	3·996	2·764	45·472
																															Ratio in terms of the Crushing Force - - -				·254	·075	·052	1·000

MESSRS. THOMAS, BLAENAVON

No. 1.—COLD

MANUFACTURE.

No. 1.—Cold Blast.—Pig Iron, manufactured from the following ingredients, viz.:—

Three-quarter coal and old coal coke.
Rough and smooth limestone in raw state.
Black Pin—Pwll Llacca—Ball Mine } calcined.
Bottom Vein—Grey Vein " }
Smelted entirely by cold blast.

CASTING.

Cast - - - 7 October 1856.
Barometer - - - 21·95
Thermometer - - - 67°

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	3	7
Runners - -	0	3	0½
Slag and waste	1	0	16
Coals consumed	4	0	18

Time of—	hrs.	min.
Melting - - -	0	52
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1630			1	7·134	1·299	·001	·002	·006	·009	–	–	–	·012	31,000	23,391	2·03	2·00	8·1200	·051	·001	·123	·015	–	–	·182	14,500	8,928	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1631	Mark $\frac{14}{2}$.	Slow -	2	7·171	1·3	·000	·001	·004	·007	–	–	–	·009	33,100	24,037	1·98	2·01	7·9993	·057	·005	·125	·018	–	–	·196	13,900	8,688	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1632			3	7·175	1·3	·001	·004	·006	·009	–	–	–	·011	32,000	24,108	–	–	–	–	–	–	–	–	–	–	–	–	1·797	6·	1·	5·	14·	9·	5·	–	–	–	–	–	–	17°·5
1633	CAST. 7 October 1856.		1	7·198	1·3	·000	·003	·006	·008	·012	–	–	·014	38,000	28,628	2·03	1·98	7·9584	·055	·002	·116	·013	·195	·035	·223	15,900	9,989	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1634		Horizontal. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1635	TESTED. Tensile, 9 Dec. 1857.		3	7·200	1·3	·001	·004	·006	·008	·010	–	–	·012	37,900	28,553	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·	·7	2·3	–	–	–	–	–	–	–	–	–	4°·8
1636	Temp. 59°.		1	7·175	1·3	·001	·005	·009	·013	–	–	–	·015	34,000	25,615	2·00	1·99	7·9202	·060	·006	·130	·020	–	–	·213	12,500	7,891	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1637	Transverse, 8 Oct. 1857.	Quick -	2	7·177	1·3	·002	·005	·008	·010	–	–	–	·015	33,500	25,239	2·01	2·01	8·1206	·060	·005	·127	·020	–	–	·189	12,600	7,758	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1638	Temp. 57°.		3	7·171	1·3	·000	·002	·004	·007	–	–	–	·011	32,000	24,108	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·8	1·1	2·7	–	–	–	–	–	–	–	–	–	7°·2
1639	Torsion, 22 Oct. 1857. Temp. 54°.		1	7·088	1·299	·001	·004	·006	·009	–	–	–	·011	31,500	23,768	1·98	2·02	8·0791	·064	·005	–	–	–	–	·137	9,500*	5,878*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1640	Crushing, 2 Feb. 1859.	Slow -	2	7·084	1·3	·001	·004	·007	·010	–	–	–	·012	31,900	24,033	2·02	2·02	8·2420	·057	·005	·135	·022	–	–	·134	12,000	7,279	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1641	Temp. 54°.		3	7·076	1·3	·001	·004	·008	·011	–	–	–	·012	31,900	24,033	–	–	–	–	–	–	–	–	–	–	–	–	1·799	4 3	1·1	3·2	–	–	–	–	–	–	–	–	–	7°·6
1642	FRACTURE.		1	7·087	1·299	·001	·003	·005	·007	–	–	–	·010	34,800	26,258	2·01	2·01	8·1206	·056	·002	·134	·020	–	–	·166	11,200	6,896	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1643	Medium Grey.	Vertical. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–	2·00	2·00	8·0000	·055	·003	·125	·015	–	–	·145	10,500*	6,562*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1644	Dull. Regular. Fine Grain.		3	7·100	1·3	·002	·005	·009	·011	–	–	–	·011	30,000	22,601	–	–	–	–	–	–	–	–	–	–	–	–	1·797	4·	1·3	2·7	–	–	–	–	–	–	–	–	–	7°·3
1645	Good working qualities.		1	–	–	–	–	–	–	–	–	–	–	–	–	1·96	1·97	7·6065	·050	·005	–	–	–	–	·136	7,750*	5,094*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1646	Inclined to be soft.	Quick -	2	7·091	1·3	·002	·005	·008	·010	·015	–	–	·017	37,600	28,327	1·99	2·01	8·0397	·053	·009	·130	·021	–	–	·168	12,000	7,462	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1647			3	7·131	1·3	·001	·004	·006	·008	·011	–	–	·013	37,500	28,252	–	–	–	–	–	–	–	–	–	–	–	–	1·799	3·2	·6	2·6	–	–	–	–	–	–	–	–	–	10°·
	GENERAL MEAN - - -			7·137	1·3	·001	·003	·006	·009	·012	–	–	·012	33,780	25,456	2·00	2·00	8·0000	·056	·004	·127	·018	·195	·035	·171	12,031*	7,493*	1·798	4·	·9	3·1	14·	9·	5·	–	–	–	–	–	–	9°·

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 49, at the end.

IRON WORKS, MONMOUTHSHIRE.

BLAST.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·40
Silicon	1·36
Sulphur	0·07
Phosphorus	0·29
Manganese	0·28

TEST.

TORSION. Breaking Weight. Observed.	TORSION. Breaking Weight. Reduced to per Square Inch.	TORSION. Fracture. Angles from Transverse Base.	TORSION. Fracture. Diameters long.	CRUSHING. Dimensions. Length.	Diameter.	Ratio $\frac{L.}{D.}$	Resistance or Variations in Form under the different Pressures of 15,000 lbs. Depression.	15,000 lbs. Set.	15,000 lbs. Restoration.	20,000 lbs. Depression.	20,000 lbs. Set.	20,000 lbs. Restoration.	25,000 lbs. Depression.	25,000 lbs. Set.	25,000 lbs. Restoration.	30,000 lbs. Depression.	30,000 lbs. Set.	30,000 lbs. Restoration.	35,000 lbs. Depression.	35,000 lbs. Set.	35,000 lbs. Restoration.	CRUSHING. Breaking Weight. Observed.	CRUSHING. Breaking Weight. Reduced to per Square Inch.	MEAN. Specific Gravity.	MEAN. Tensile.	MEAN. Transverse.	MEAN. Torsion.	MEAN. Crushing.	RATIO—TON AS UNITY. Tensile.	RATIO—TON AS UNITY. Transverse.	RATIO—TON AS UNITY. Torsion.	RATIO—TON AS UNITY. Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,570	6,763	40°	2·00	1·3	·6	2·16	·029	·015	·014	·064	·042	·022	·147	·115	·032	–	–	–	–	–	–	25,900	91,602	7·160	24,145	8,808	6,763	91,602	10·779	3·932	3·019	40·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,000*	4,308*	34°	1·45	1·3	·6	2·16	·019	·007	·012	·050	·035	·015	·088	·055	·033	·175	·138	·037	–	–	–	30,300	107,164	7·190	28,590	9,989	4,308*	107,164	12·763	4·459	1·923*	47·841
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200	5,169	26°	1·37	1·3	·6	2·16	·027	·013	·014	·056	·036	·020	·125	·097	·028	–	–	–	–	–	–	25,900	91,602	7·174	24,987	7,824	5,169	91,602	11·154	3·492	2·307	40·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200*	5,152*	30°	1·40	1·3	·6	2·16	·029	·015	·014	·061	·041	·020	–	–	–	–	–	–	–	–	–	24,000	84,882	7·082	23,944	6,579*	5,152*	84,882	10·389	2·937*	2·300*	37 893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,050*	4,523*	33°	1·25	1·3	·6	2·16	·030	·026	·004	·085	·060	·025	–	–	–	–	–	–	–	–	–	20,500*	72,503*	7·093	24,429	6,729*	4,523*	72,503*	10·905	3·004*	2 019*	32·367*
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,000*	4,293*	36°	1·50	1·3	·6	2·16	·022	·010	·012	·049	·026	·023	·087	·056	·031	–	–	–	–	–	–	29,300	103,627	7·111	28,289	6,278*	4,293*	103,627	12·629	2·802*	1·916*	46·262
1,170*	5,034*	33°	1·49	1·3	·6	2·16	·026	·014	·012	·061	·040	·021	·112	·081	·031	–	–	–	–	–	–	25,983	91,897	7·137	25,456	7,493*	5,034*	91,897*	11·364	3·345*	2·247*	41·025*
Combined Means — Slow, Gradual and Quick cooling — Horizontal																								7·175	25,572	8,651	5,413*	96,789	11·420	3·862	2·416*	43·209
Combined Means — Slow, Gradual and Quick cooling — Vertical																								7·094	25,324	6,528*	4,656*	87,004*	11·305	2·914*	2·078*	38·839*
Combined Means — Horizontally and Vertically cast — Slow																								7·121	24,044	7,698*	5,957*	88,242	10·733	3·436*	2·659*	39·393
Combined Means — Horizontally and Vertically cast — Gradual																								7·146	26,509	8,359*	4,415*	89,834*	11·834	3·731*	1·970*	40·104*
Combined Means — Horizontally and Vertically cast — Quick																								7·143	26,638	7,051*	4,732*	97,615	11·891	3·147*	2·112*	43·577
Ratio in terms of the Crushing Force																													·277	·081	·054	1·000

MESSRS. THOMAS, BLAENAVON

COMMON

MANUFACTURE.

Common Forge marked C.—Pig Iron, manufactured from the following ingredients; viz.:—
Three-quarter coal and old coal coke.
Rough and smooth limestone in raw state.
Black Pin—Pwll Llacca—Ball Mine } calcined.
Bottom Vein—Grey Vein - - }
Smelted entirely by cold blast.

CASTING.

Cast - - - 7 October 1856.
Barometer - - - 29·95
Thermometer - - - 67°

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	1	13½
Runners - -	0	3	4½
Slag and waste	1	1	13
Coals consumed	4	0	5

Time of—	hrs.	min.
Melting - - -	1	14
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1648			1	7·326	1·3	·000	·001	·003	·005	·007	–	–	·008	38,500	29,005
1649	Mark $\frac{14}{3}$.	Slow -	2	7·333	1·3	·001	·003	·005	·006	·008	–	–	·011	39,900	30,060
1650			3	7·329	1·3	·000	·002	·003	·005	·006	–	–	·010	39,500	29,759
1651	CAST. 7 October 1856.		1	–	–	–	–	–	–	–	–	–	–	–	–
1652		Gradual	2	7·338	1·3	·001	·003	·005	·006	·008	–	–	·009	39,000	29,382
1653	TESTED. Tensile, 10 Dec. 1857.		3	–	–	–	–	–	–	–	–	–	–	–	–
1654	Temp. 58°.		1	7·256	1·3	·000	·002	·004	·005	·007	·010	–	·012	43,900	33,073
1655	Transverse, 8 Oct. 1857.	Quick -	2	7·263	1·3	·000	·002	·004	·005	·006	·008	–	·008	42,000	31,642
1656	Temp. 60°.		3	7·262	1·3	·000	·001	·003	·004	005	·007	–	·009	44,600	33,601
1657	Torsion, 23 Oct. 1857.		1	–	–	–	–	–	–	–	–	–	–	–	–
1658	Temp. 55°.	Slow -	2	7·242	1·3	·000	·001	·002	·004	·005	·007	–	·009	41,300	31,115
1659	Crushing, 3 Feb. 1859. Temp. 56°.		3	7·252	1·3	·000	·002	·003	·005	·007	·008	–	·009	42,900	32,320
1660			1	7·204	1·299	·000	·003	–	–	–	–	–	·005	24,500*	18,486*
1661	FRACTURE. Light Grey.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1662	Dull. Regular.		3	7·340	1·3	·000	·003	·004	·006	–	–	–	·007	34,000*	25,615*
1663	Fine Grain.		1	–	–	–	–	–	–	–	–	–	–	–	–
1664	Very difficult working.	Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–
1665			3	7·195	1·3	·001	·005	·007	–	–	–	–	·009	26,000*	19,588*
	GENERAL MEAN - - -			7·278	1·3	·000	·002	·004	·005	·006	·008	–	·009	38,003*	28,637*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B.D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1648	2·00	2·00	8·0000	·053	·005	·101	·010	–	–	·142	12,500*	7,812*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1649	2·05	1·97	7·9558	·049	·001	·105	·008	–	–	·133	12,500	7,730	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1650	–	–	–	–	–	–	–	–	–	–	–	–	1·798	2·9	·0	2·9	–	–	–	–	–	–	–	–	–	4°
1651	2·02	1·96	7·7600	·050	·002	·106	·008	–	–	·125	11,200*	7,216*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1652	2·05	2·04	8·5312	·050	·003	101	·005	·164	·020	·164	15,000	8,794	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1653	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1654	2·02	1·99	7·9994	·052	·005	·108	·010	·175	·025	·210	16,500	10,313	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1655	1·99	2·00	7·9600	·050	·003	·101	·005	·167	·021	·167	16,000	10,050	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1656	–	–	–	–	–	–	–	–	–	–	–	–	1·798	1·5	·0	1·5	4·	1·	3·	–	–	–	–	–	–	4°
1657	1·97	2·01	7·9589	·040	·005	·080	·009	–	–	·120	11,750*	7,381*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1658	2·01	2·00	8·0400	·053	·003	·113	·015	–	–	·146	12,100	7,524	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1659	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·5	·0	1·5	–	–	–	–	–	–	–	–	–	6°
1660	2·02	2·03	8·3642	·051	·002	·109	·009	–	–	·114	11,000*	6,607*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1661	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1662	–	–	–	–	–	–	–	–	–	–	–	–	1·797	1·5	·0	1·5	3·8	·0	3·8	–	–	–	–	–	–	6°
1663	1·95	1·97	7·5727	·048	·008	–	–	–	–	·120	7,000*	4,624*	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1664	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1665	–	–	–	–	–	–	–	–	–	–	–	–	1·8	1·	·0	1·	–	–	–	–	–	–	–	–	–	2°
	2·01	2·00	8·0400	·049	003	·102	·009	·168	·022	·144	12,535*	7,805*	1·798	1·7	·0	1·7	3·9	·5	3·4	–	–	–	–	–	–	4°·4

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 50, at the end.

IRON WORKS, MONMOUTHSHIRE.

FORGE C.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·64
Silicon	1·68
Sulphur	0·08
Phosphorus	0·27
Manganese	0·66

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·329	29,608	7,771*	5,376	134,750	13·217	3·469*	2·400	60·156
1,250	5,376	35°	1·78	1·3	·6	2·16	·016	·010	·006	·035	·020	·015	·049	·026	·023	·072	·040	·032	·108	·069	·039	38,100	134,750									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·338	29,382	8,005*	- -	- -	13·116	3·573*	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·260	32,772	10,181	6,451*	125,201	14·630	4·545	2·879*	55·893
1,500*	6,451*	30°	1·25	1·3	·6	2·16	·018	·003	·015	·035	·013	·022	·054	·025	·029	·081	·045	·036	·150	·103	·047	35,400	125,201									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·274	31,717	7,452*	5,816	123,433	14·159	3·326*	2·596	55·104
1,350	5,816	35°	1·70	1·3	6	2·16	·019	·003	·016	·038	·016	·022	·058	·030	·028	·090	·054	·036	-	-	-	34,900	123,433									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·272	22,050*	6,607*	7,151	140,056	9·843*	2·949*	3·192	62·525
1,660	7,151	38°	2·10	1·3	·6	2·16	·016	·003	·013	·030	·010	·020	·047	·018	·029	·067	·031	·036	·098	·057	·041	39,600	140,056									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·195	19,588*	4,624*	4,972*	- -	8·744*	2·064*	2·219*	—
1,160*	4,972*	37°	1·90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,384*	5,953*	35°	1·74	1·3	·6	2·16	·017	·005	·012	·035	·015	·020	·052	·025	·027	·078	·043	·035	·119	·076	·043	37,000	130,860	7·268	28,637*	7,805*	5,953*	130,860	12·784*	3·484*	2·657*	58·419
																								7·301	30,931	8,652*	5,913*	129,976	13·808	3·862*	2·639*	58·033
																								7·246	25,425*	6,534*	5,979*	131,745	11·350*	2·916*	2·669*	58·814
																								7·288	30,662	7,611*	5,596	129,092	13·688	3·397*	2·498	57·183
																								7·305	25,716*	7,306*	7,151	140,056	11·480*	3·261*	3·192	62·525
																								7·228	26,171*	7,402*	5,711*	125,201	11·683*	3·304*	2·549*	55·893
																													·218	·059	·045	1·000

Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -
Vertical - - - -
Horizontally and Vertically cast - - - Slow - - - - -
Gradual - - - -
Quick - - - -
Ratio in terms of the Crushing Force - - -

MESSRS. THOMAS, BLAENAVON

No. 3.—COLD

MANUFACTURE.

No. 3.—Cold Blast.—Pig Iron, manufactured from the following ingredients, viz.:—
Three-quarter coal and old coal coke.
Rough and smooth limestone in raw state.
Black Pin—Pwll Llacca—Ball Mine } calcined.
Bottom Vein—Grey Vein - - }
Smelted entirely by cold blast.

CASTING.

Cast - - -	8 October 1856.
Barometer - - -	29·95
Thermometer - -	67·

Weight of—	cwts.	qrs.	lbs.
Charge - - -	5	0	0
Castings - -	3	0	21
Runners - -	0	3	0
Slag and waste -	0	3	4
Coals consumed -	3	2	11

Time of—	hrs.	min.
Melting - - -	0	55
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1666			1	7·200	1·3	·002	·006	·011	·014	–	–	–	·015	32,500	24,485
1667	Mark $\frac{14}{4}$.	Slow -	2	7·191	1·3	·000	·002	·004	·008	–	–	–	·010	32,100	24,183
1668			3	7·207	1·3	·000	·003	·006	·008	–	–	–	·010	32,800	24,711
1669	CAST. 8 October 1856.		1	7·179	1·299	·002	·005	·009	·012	–	–	–	·015	30,500	23,013
1670	TESTED.	Gradual	2	7·169	1·3	·001	·003	·006	·009	–	–	–	·013	33,300	25,088
1671	Tensile, 10 Dec. 1857. Temp. 59°.		3	7·179	1·3	·000	·001	·005	·008	–	–	–	·009	31,600	23,807
1672			1	7·176	1·3	·002	·005	·007	·010	–	–	–	·013	32,900	24,786
1673	Transverse, 9 Oct. 1857. Temp. 58°.	Quick -	2	7·186	1·3	·001	·004	·007	·009	·015	–	–	·015	35,000	26,368
1674			3	7·149	1·299	·002	·004	·007	·010	–	–	–	·011	32,300*	24,372*
1675	Torsion, 23 Oct. 1857. Temp. 56°.		1	7·162	1·3	·001	·003	·006	·009	–	–	–	·009	30,000	22,601
1676	Crushing, 3 Feb. 1859.	Slow -	2	7·151	1·3	·001	·004	·006	·009	–	–	–	·010	31,000	23,355
1677	Temp. 56°.		3	7·199	1·3	·000	·003	·006	·009	–	–	–	·010	32,600	24,560
1678	FRACTURE. Medium Grey.		1	7·146	1·3	·002	·005	·009	·011	–	–	–	·011	30,000	22,601
1679	Dull.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–
1680	Regular. Fine Grain.		3	6·918	1·3	·003	·005	·009	–	–	–	–	·010	27,500*	20,718*
1681	Good working qualities.		1	–	–	–	–	–	–	–	–	–	–	–	–
1682	Inclined to be soft.	Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–
1683			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN - - -			7·158	1·3	·001	·004	·007	·009	·015	–	–	·011	31,714*	23,903*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1666	2·04	2·01	8·2418	·055	·004	·124	·016	·241	·062	·241	15,000	9,099	–	–	–	–	–	–	–	–	–	–	–	–	–
1667	2·02	2·05	8·4890	·054	·003	·117	·014	·219	·060	·240	15,300	9,011	–	–	–	–	–	–	–	–	–	–	–	–	–
1668	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·5	·0	2·5	10·1	6·3	3·8	–	–	–	–	–	13°·4
1669	2·05	2·01	8·2822	·056	·004	·130	·020	–	–	·184	12,100	7,304	–	–	–	–	–	–	–	–	–	–	–	–	–
1670	2·01	2·03	8·2830	·060	·002	·140	·026	–	–	·193	12,100*	7,304*	–	–	–	–	–	–	–	–	–	–	–	–	–
1671	–	–	–	–	–	–	–	–	–	–	–	–	1·798	4·4	1·6	2·8	–	–	–	–	–	–	–	–	12°·8
1672	2·03	1·97	7·8782	·059	·003	·138	·023	–	–	·206	12,500	7,933	–	–	–	–	–	–	–	–	–	–	–	–	–
1673	1·98	2·03	8·1593	·055	·003	·125	·015	–	–	·209	13,000	7,966	–	–	–	–	–	–	–	–	–	–	–	–	–
1674	–	–	–	–	–	–	–	–	–	–	–	–	1·794	4·4	1·5	2·9	–	–	–	–	–	–	–	–	5°·7
1675	1·96	1·97	7·6065	·049	·001	–	–	–	–	·136	9,500	6,244	–	–	–	–	–	–	–	–	–	–	–	–	–
1676	1·96	1·97	7·6065	·056	·001	·148	·025	–	–	·170	10,600	6,967	–	–	–	–	–	–	–	–	–	–	–	–	–
1677	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·5	·0	2·5	–	–	–	–	–	–	–	–	10°·3
1678	1·96	1·97	7·6065	·060	·003	·146	·023	–	–	·146	10,000	6,573	–	–	–	–	–	–	–	–	–	–	–	–	–
1679	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1680	–	–	–	–	–	–	–	–	–	–	–	–	1·797	4·1	1·2	2·9	–	–	–	–	–	–	–	–	9°·1
1681	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1682	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1683	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2·00	2·00	8·0000	·056	·003	·133	·020	·230	·061	·191	12,233*	7,600*	1·796	3·6	·9	2·7	10·1	6·3	3·8	–	–	–	–	–	10°·2

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 51, at the end.

IRON WORKS, MONMOUTHSHIRE.

BLAST.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·88
Silicon	1·09
Sulphur	0·08
Phosphorus	0·38
Manganese	0·66

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of												Breaking Weight.											
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	$\frac{L.}{D.}$ Ratio	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·199	24,459	9,055	6,004	88,065	10·919	4·042	3·082	39·312
1,600	6,904	37°	1·81	1·3	·6	2·16	·028	·012	·016	·054	·032	·022	-	-	-	-	-	-	-	-	-	24,900	88,065									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·175	23,969	7,304*	5,419	88,065	10·700	3·260*	2·419	39·312
1,260	5,419	30°	1·62	1·3	·6	2·16	·028	·015	·013	·059	·036	·023	-	-	-	-	-	-	-	-	-	24,900	88,065									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·170	25,175*	7,949	4,546*	87,711	11·238*	3·548	2·029*	39·156
1,050*	4,546*	30°	1·50	1·3	·6	2·16	·026	·012	·014	·056	·035	·021	-	-	-	-	-	-	-	-	-	24,800	87,711									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·170	23,505	6,605	6,031	88,065	10 493	2·948	2·692	39·312
1,400	6,031	33°	1·56	1·3	·6	2·16	·026	·011	·015	·055	·034	·021	-	-	-	-	-	-	-	-	-	24,900	88,065									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·032	21,659*	6,573	5,471	84,882*	9·669*	2·934	2·441	37·893*
1,270	5,471	35°	1·69	1·3	·6	2·16	·029	·017	·012	·063	·040	·023	-	-	-	-	-	-	-	-	-	24,000*	84,882*									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,316*	5,674*	33°	1·63	1·3	·6	2·16	·027	·013	·014	·057	·035	·022	-	-	-	-	-	-	-	-	-	24,700*	87,358*	7·158	23,903*	7,600*	5,674*	87,358*	10·670*	3·392*	2·533*	38·935*
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·181	24,534*	8,102*	5,623*	87,947	10·952*	3·616*	2·510*	39·262
																								7·101	22,767*	6,594	5,751	86,474*	10·163*	2·943	2·567	38·604*
Horizontally and Vertically cast - - - Slow - - - - -																								7·185	23,982	7,830	6,467	88,065	10·706	3·495	2·887	39·312
																								7·103	22,814*	6,938*	5,445	86,474*	10·184*	3·097*	2·450	38·604*
																								7·170	25,175*	7,949	4,546*	87,711	11·238*	3·548	2·029*	39 156
																													Ratio in terms of the Crushing Force - - -				·273	·086	·064	1·000

MESSRS. THOMAS, BLAENAVON

BRIGHT

MANUFACTURE.

Bright Forge, marked B., manufactured from the following ingredients; viz.:—

Three-quarter coal and old coal coke.
Rough and smooth limestone in raw state.
Black Pin—Pwll Llacca—Ball Mine } calcined.
Bottom Vein—Grey Vein - - }
Smelted entirely by cold blast.

CASTING.

Cast - -	9 October 1856.
Barometer - -	30·17
Thermometer - -	64·

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	2	1	0
Runners - -	0	3	24
Slag and waste -	0	3	5
Coals consumed -	3	3	10

Time of—	hrs.	min.
Melting - - -	0	40
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1684	Mark $\frac{14}{5}$.	Horizontal. Slow	1	7·304	1·3	·000	·003	–	–	–	–	–	·007	24,000*	18,081*	2·05	1·94	7·7153	·051	·001	–	–	–	–	·110	10,000*	6,480*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1685			2	7·301	1·3	·002	·004	·006	·007	–	–	–	·008	34,000	25,615	2·01	2·06	8·5296	·052	·002	·106	·008	–	–	·130	11,900*	6,975*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1686	CAST.		3	7·308	1·3	·000	·003	·005	·007	–	–	–	·011	34,900	26,293	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·1	·7	1·4	–	–	–	–	–	–	–	–	–	3°·4
1687	9 October 1856.		1	7·299	1·298	·002	·003	·007	·009	–	–	–	·011	33,200	25,089	2·03	2·00	8·1200	·052	·002	·108	·010	–	–	·131	12,300	7,573	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1688	TESTED.		2	7·118	1·299	·001	·004	·006	·007	–	–	–	·009	34,900	26,333	2·02	1·98	7·9192	·050	·000	·107	·008	–	–	·124	11,200	7,071	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1689	Tensile, 10 Dec. 1857.		3	7·328	1·3	·000	·003	·005	·007	–	–	–	·010	34,900*	26,293*	–	–	–	–	–	–	–	–	–	–	–	–	1·794	1·6	·0	1·6	–	–	–	–	–	–	–	–	–	5°·3
1690	Temp. 60°.		1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1691	Transverse, 9 Oct. 1857.	Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1692	Temp. 58°.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1693	Torsion, 23 Oct. 1857.		1	6·702	1·298	·001	·004	·007	–	–	–	–	·011	27,500*	20,782*	1·96	1·97	7·6065	·055	·003	·123	·013	–	–	·127	10,300*	6,770*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1694	Temp. 56°.	Slow	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1695	Crushing, 3 Feb. 1859.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1·797	–	–	–	–	–	–	–	–	–	–	–	–	–	1°.
1696	Temp. 56°.		1	–	–	–	–	–	–	–	–	–	–	–	–	1·94	1·96	7·4527	·057	·001	–	–	–	–	·100	7,000*	4,696*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1697	FRACTURE.		2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1698	Light Grey.	Vertical. Gradual	3	6·841	1·298	·001	·004	–	–	–	–	–	·007	22,000*	16,625*	–	–	–	–	–	–	–	–	–	–	–	–	1·799	–	–	–	–	–	–	–	–	–	–	–	–	–	2°·2
1699	Dull.		1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1700	Regular.		2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1701	Fine Grain.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Difficult working.	Quick																																							
	GENERAL MEAN - - -			7·150	1·299	·001	·003	·006	·007	–	–	–	·009	30,675*	23,139*	2·00	1·98	7·8408	·052	·002	·111	·010	–	–	·120	10,450*	6,594*	1·797	1·8	·3	1·5	–	–	–	–	–	–	–	–	–	2°·9

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 52, at the end.

IRON WORKS, MONMOUTHSHIRE.

FORGE B.

CHEMICAL ANALYSIS.

—Nil.—

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio L. D.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,060*	4,566*	40°	1·65	1·3	·6	2·16	·018	·005	·013	·033	·012	·021	·050	·020	·030	·073	·038	·035	·121	·080	·041	36,400	128,738	7·304	23,329*	6,727*	4,566*	128,738	10·414*	3·003*	2·038*	57·472
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
1,440	6,234	36°	1·52	1·3	·6	2·16	·017	·002	·015	·032	·010	·022	0·51	·021	·030	·079	0·41	·038	-	-	-	34,900	123,433	7·248	25,905*	7,322	6,234	123,433	11·564*	3·268	2·782	55·104
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
500*	2,154*	25°	0·95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
600*	2,576*	35°	1·40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
- -	- -	- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -								
900*	3,882*	34°	1·33	1·3	·6	2·16	·018	·004	·014	·033	·011	·022	·051	·021	·030	·076	·040	·036	121	·080	·041	35,650	126,086	7·150	23,139*	6,594*	3,882*	126,086	10·329*	2·943*	1·733*	56·288

Combined Means	Slow, Gradual, and Quick cooling	Horizontal	7·276	24,617*	7,024*	5,400*	126,086	10·989*	3·135*	2·410*	56·288
		Vertical	6·771	18,703*	5,733*	2,365*	- -	8·349*	2·559*	1·055*	—
	Horizontally and Vertically cast	Slow	7·003	22,055*	6,748*	3,360*	128,738	9·845*	3·012*	1·500*	57·472
		Gradual	7·045	21,265*	6,009*	4,405*	123,433	9·493*	2·682*	1·966*	55·104
		Quick	—	—	—	—	—	—	—	—	—
								Ratio in terms of the Crushing Force			1·000

BLAENAVON IRON WORKS, MONMOUTHSHIRE.

(Mr. H. Thomas.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ores.

I. *Black Pins.*—A nodular form of clay ironstone, having cracks of contraction partly filled with a white crystalline substance, composed of the *carbonates of iron, lime,* and *magnesia.*

II. *Pwll Llacca.*—A clay ironstone, brownish grey in colour, and homogeneous. The seam measures 2½ inches, barely.

III. *Bottom Vein.*—A clay ironstone, light brownish grey in colour, homogeneous. The seam measures three inches.

IV. *Ball Mine.*—Brownish grey clay ironstone, containing a few very thin seams of limespar.

V. *Grey Vein.*—Clay ironstone, brownish grey in colour, with very rough surface of fracture. The seam measures two inches.

	I. Black Pins.	II. Pwll Llacca.	III. Bottom Vein.	IV. Ball Mine.	V. Grey Vein.
Protoxide of iron	47·02	47·60	42·04	51·28	39·80
Oxide of manganese	1·00	0·46	0·87	1·11	1·17
Lime	2·57	0 77	1·03	0·78	2·41
Magnesia	3·23	2·30	2·51	0·53	3·30
Carbonic acid	34·30	32·90	29·52	33·32	30·04
Phosphoric acid	0·92	0·71	0·90	0·74	1·02
Bisulphide of iron	0·25	0·08	0·06	0·06	0·05
Water, hygroscopic	0·34	0·32	0·36	0·18	0·54
Water, in combination	1·58	1·28	2·00	1·67	2·12
Organic matter	0·40	0·30	0·30	0·35	0·45
Clay, ignited	8·63	13·60	20 87	10·33	19·40
	100·24	100·32	100·46	100·35	100·30
Metallic iron	36·77	37·32	33·20	40·12	31·45

Fuel.

Coke, made from the Three Quarters Coal.

An average sample of the coke contained—

Sulphur - - - - - - - - 0·74 per cent.

and left, on burning,

Ash - - - - - - - - 5·35 per cent.

the ash consisting of *silica, alumina,* with *peroxide of iron,* and a little *lime.*

BLAENAVON IRON WORKS, MONMOUTHSHIRE—*continued.*

FLUXES.

Two kinds of limestone are employed. They are distinguished as "rough" and "smooth."

I. *Rough limestone* has a large crystalline structure, is light brown in colour, and contains numerous fossil shells.

II. *Smooth limestone* has an oolitic structure, and is usually pale in colour.

(Samples dried at 212° Fahrenheit.)

	Rough.	Smooth.
Carbonate of lime - - - - -	98·55	99·26
Carbonate of magnesia - - - -	0·54	0·63
Carbonate of iron - - - - -	0·50	0·33
Phosphate of lime - - - - -	0·03	0·02
Silica (sand) - - - - - -	0·73	0·27
	100·35	100·51

IRONS.

Smelted entirely with cold blast.

Important Constituents in 100 *Parts.*

	I. No. 1 and C. Pig.	II. No. 1 Pig.	III. Common Forge.	IV. No. 3 Pig.
Carbon, as graphite - -	2·82	3·40	2·64	2·88
Silicon - - - - - -	0·81	1·36	1·68	1·09
Sulphur - - - - - -	0·06	0·07	0·08	0·08
Phosphorus - - - - -	0·38	0·29	0·27	0·38
Manganese - - - - -	0·53	0·28	0·66	0·66

Remark.—Analyses of other samples of iron, representing supplies from these works, are given in the Appendix.

MESSRS. FIRMSTONE,

COLD BLAST

MANUFACTURE.

Pontypool Pig Iron of the first melting, taken direct from the Cold Blast Furnace.

Cast - - - 6 October 1856.
Barometer - - - 29·99
Thermometer - - - 67·

CASTING.

Weight of—	cwt.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	1	3	24
Runners - -	0	3	21
Slag and Waste	1	1	7
Coals consumed	3	3	13

Time of—	hrs.	min.
Melting - - -	1	34
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting - -	0	15

CHEMICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1594			1	-	-	-	-	-	-	-	-	-	-	-	-
1595	Mark $\frac{13}{1}$.	Slow -	2	-	-	-	-	-	-	-	-	-	-	-	-
1596			3	-	-	-	-	-	-	-	-	-	-	-	-
	CAST.														
1597	6 October 1856.		1	7·164	1·3	·003	·006	·009	·011	·013	-	-	·019	37,500*	28,252*
1598		Horizontal. Gradual	2	7·162	1·3	·003	·005	·007	·009	·011	-	-	·015	36,000*	27,122*
1599	TESTED.		3	7·147	1·3	·000	·003	·004	·007	·009	-	-	·013	37,800*	28,478*
	Tensile, 13 Oct. 1857. Temp. 63°.														
1600			1	7·196	1·3	·002	·005	·009	·011	·015	-	-	·017	37,300	28,101
1601	Transverse, 22 Aug. 1857. Temp. 70°.	Quick -	2	7·180	1·3	·001	·003	·005	008	·010	-	-	·013	37,000	27,875
1602			3	7·197	1·3	·000	·003	·005	·006	·009	-	-	·014	37,700	28,402
	Torsion, 21 Oct. 1857. Temp. 60°.														
1603			1	7·143	1·3	·002	·005	·008	-	-	-	-	·016	27,000*	20,341*
1604	Crushing, 3 Feb. 1859.	Slow -	2	-	-	-	-	-	-	-	-	-	-	-	-
1605	Temp. 50°.		3	7·165	1·3	·004	·008	·011	-	-	-	-	·016	29,000*	21,848*
1606	FRACTURE.		1	-	-	-	-	-	-	-	-	-	-	-	-
1607	Medium Grey.	Vertical. Gradual	2	-	-	-	-	-	-	-	-	-	-	-	-
1608	Bluish. Regular. Fine Grain.		3	-	-	-	-	-	-	-	-	-	-	-	-
1609	Good working quality.		1	-	-	-	-	-	-	-	-	-	-	-	-
1610		Quick -	2	-	-	-	-	-	-	-	-	-	-	-	-
1611			3	-	-	-	-	-	-	-	-	-	-	-	-
	GENERAL MEAN - - -			7·166	1·3	·002	·005	·007	·009	·011	-	-	·015	34,912*	26,302*

TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
2·02	2·01	8·1610	·055	·002	·117	·012	-	-	·166	12,500*	7,658*
1·99	2·03	8·2005	·055	·002	·116	·012	-	-	·148	11,600	7,072
-	-	-	-	-	-	-	-	-	-	-	-
2·05	1·93	7·6360	·055	·001	·125	·010	-	-	·150	11,200*	7,333*
2·04	2·00	8·1600	·055	·002	·117	·010	-	-	·186	13,600	8,333
-	-	-	-	-	-	-	-	-	-	-	-
1·98	2·00	7·9200	·052	·004	-	-	-	-	·110	8,000*	5,050*
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
2·01	2·02	8·2016	·060	·003	-	-	-	-	·105	7,500*	4,572*
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
2·01	2·00	8·0400	·055	·002	·118	·011	-	-	·144	10,733*	6,669*

TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
1·797	2·6	·2	2·4	-	-	-	-	-	-	-	-	-	5°·1
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
1·798	2·1	·0	2·1	-	-	-	-	-	-	-	-	-	6°·
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
1·797	-	-	-	-	-	-	-	-	-	-	-	-	5°·
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
1·797	2·3	·1	2·2	-	-	-	-	-	-	-	-	-	5°·3

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 53, at the end.

PONTYPOOL IRON WORKS.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·42
Silicon	1·46
Sulphur	0·12
Phosphorus	0·32
Manganese	0·42

TEST.

TORSION.				CRUSHING.																			MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200*	5,169*	33°	1·70	1·3	·6	2·16	·020	·011	·009	·049	·030	·019	·089	·062	·027	–	–	–	–	–	–	27,600	97,614	7·157	27,950*	7,365*	5,169*	97,614	12·477*	3·287*	2·307*	43·577
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,450	6,236	40°	1·75	1·3	·6	2·16	·019	·005	·014	·040	·019	·021	·071	·043	·028	–	–	–	–	–	–	29,700	105,141	7·191	28,126	7,833*	6,236	105,041	12·556	3·496*	2·783	46·893
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,000*	4,301*	30°	1·50	1·3	·6	2·16	·021	·009	·012	0·45	0·25	0·20	0·85	0·55	0·30	–	–	–	–	–	–	27,200	96,200	7·154	21,094*	5,050*	4,301*	96,200	9·416*	2·254*	1·920*	42·946
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,572*	- -	- -	- -	2·041*	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	—	—	—	—	—	—	—	—	—
1,213*	5,235*	34°	1·65	1·3	·6	2·16	·020	·008	·012	·045	·020	·025	·082	·053	·029	–	–	–	–	–	–	28,167	99,618	7·169	26,302*	6,669*	5,235*	99,618	11·742*	2·977*	2·337*	44·468

Combined Means	Slow, Gradual and Quick cooling	Horizontal	7·174	28,038*	7,599*	5,702*	101,328	12·516*	3·392*	2·545*	45·235
		Vertical	7·154	21,094*	4,811*	4,301*	96,200	9·416*	2·147*	1·920*	42·946
	Horizontally and Vertically cast	Slow	7·154	21,094*	5,050*	4,301*	96,200	9·416*	2·254*	1·920*	42·946
		Gradual	7·157	27,950*	5,968*	5,169*	97,614	12·477*	2·664*	2·307	43·577
		Quick	7·191	28,126	7,833*	6,236	105,041	12·556	3·496*	2·783	46·893
							Ratio in terms of the Crushing Force	·264	·066	·052	1·000

PONTYPOOL IRON WORKS, MONMOUTHSHIRE.

(Messrs. Firmstone.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ore.

A large sample of calcined ore, the clay ironstone of the district, roasted, was received, of which an average sample contained—

Iron - - - - - - - -	56·83 per cent.
Phosphoric acid - - - - -	0·73 „
Burnt clay, insoluble in hydrochloric acid	9·60 „

Fuel.

Coke.—The average of a large sample contained—

Sulphur - - - - - - - - 0·76 per cent.

and left, on burning,

Ash - - - - - - - - - 12·15 per cent.

the ash consisting principally of *lime,* but containing also *sand, clay* and *peroxide of iron* in smaller proportion.

Iron.

Specified as "Cold blast pig iron."

Important Constituents in 100 *Parts.*

Carbon, as graphite - - - - -	2·42
Silicon - - - - - - -	1·46
Sulphur - - - - - - -	0·12
Phosphorus - - - - - -	0·32
Manganese - - - - - - -	0·42

Remark.—Analyses of two other samples of iron from the Pontypool Works, of recent manufacture, are given in the Appendix.

TABLES, showing the various Qualities of CAST IRON tested at the ROYAL GUN FACTORIES, WOOLWICH.

TABLE A.—TABLE showing the various Qualities of CAST

DISTRICT.	BY WHOM SUPPLIED.	Number. Firms.	Number. Index.	DESCRIPTION.	MEAN OF MECHANICAL TESTING. Specific Gravity.	Tensile. Breaking Weight.	Tensile. Extension.	Transverse. Breaking Weight.	Transverse. Deflection.	Torsion. Breaking Weight.	Torsion. Angle of Torsion.	Crushing. Breaking Weight.	CHEMICAL ANALYSIS. Manganese.	Silicon.	Carbon. As Graphite.	Carbon. Combined.	Sulphur.	Phosphorus.	Arsenic and Copper.	ORDER of QUALITY. Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.
NORTHERN	Hematite Foundry, Whitehaven	1	11/1	No. 1. Foundry Pig	7·097	14,233	·011	4,644	·161	3,724*	7·2	52,136	0·11	3·02	3·22	–	0·00	0·06	–	40	49	52	51	50
			11/2	No. 3. Foundry Pig	7·214	17,751*	·012	5,105*	·120	4,182*	5·8	82,265	0·07	2·77	2·24	–	0·01	0·05	trace	7	44	50	48	36
			11/3	No. 4. Foundry Pig	7·196	17,566*	·012	6,100*	·152	4,977*	4·9	82,583	0·07	2·63	1·86	0·35	0·10	0·03	–	8	45	42	45	34
	Weardale Iron Company	2	19/1	No. 1. Pig Iron	7·088	18,080	·010	5,600*	·147	5,510	10·1	59,771	1·45	1·80	3·24	–	0·04	0·19	–	43	43	46	39	48
			19/2	No. 3. Pig Iron	7·158	21,859*	·011	7,374*	·181	5,968*	7·7	90,046*	1·04	4·25	2·26	–	0·06	0·07	–	21	35	25	29	23
			19/3	No. 4. Pig Iron	7·248	23,513*	·009	7,672*	·173	6,350	7·2	109,286	trace	1·18	2·15	–	0·12	0·19	–	3	28	17	19	9
			19/4	Remelted	7·180	30,333	·012	8,948	·191	6,277*	5·2	122,216	0·13	1·88	2·21	–	0·10	0·19	–	12	4	4	21	3
	South Bank Furnaces, Middlesbro'-on-Tees	3	6/1	No. 2. Toughened Pig	7·089	18,425	·008	6,260	·110	6,405	5·7	86,886	0·43	1·13	3·44	–	0·03	1·24	–	42	42	41	16	30
			6/2	No. 2. Foundry Pig	7·023	15,835	·006	5,563	·105	5,626	6·5	77,926	0·38	2·73	3·04	–	0·04	1·30	–	49	47	47	38	40
	Stockton Iron Works	4	15/1	No. 1. Hot-blast	7·148	25,810	·011	7,159	·136	5,872*	4·2	99,524	0·07	1·57	3·35	–	0·04	1·38	–	26	16	31	32	16
			15/2	No. 3. Hot-blast	7·135	22,271	·009	6,932	·134	6,305	5·7	87,063	0·06	1·43	3·31	–	0·03	1·36	–	31	33	34	20	29
NORTH MIDLAND	Butterley Iron Works, Derbyshire	5	8/1	No. 1. Foundry Pig	7·141	23,388	·010	7,106	·145	7,342	9·3	88,488	1·01	1·27	3·35	–	0·02	1·09	–	29	29	32	6	25
			8/2	No. 2. Foundry Pig	7·078	18,970	·010	6,077	·128	6,011	7·5	74,743	1·06	2·36	2·74	–	0·02	1·21	–	45	40	43	27	44
			8/3	No. 3. Foundry Pig	7·126	23,265	·009	6,692	·130	6,940	7·5	91,661	0·95	1·75	2·71	–	0·04	1·15	–	34	30	38	11	21
			8/4	No. 3. Blue Rake	7·073	24,126*	·010	7,364*	·153	6,371*	6·4	97,041	0·40	1·34	2·60	–	0·11	0·75	–	46	24	26	18	18
	West Hallum Iron Works, Ilkeston, Derbyshire	6	1/1	No. 1. Melting Pig	7·121	22,107	·012	7,587	·153	7,312	8·1	82,229*	0·88	2·23	2·31	–	0·02	0·72	–	36	34	22	7	37
			1/2	No. 2. Melting Pig	7·217	29,840	·014	9,033	·172	8,113*	8·0	119,483	0·60	1·50	2·40	–	0·06	0·34	–	6	6	3	1	7
			1/3	No. 3. Melting Pig	7·239	30,115*	·013	9,399	·157	7,973*	8·6	120,321	0·45	1·26	2·60	–	0·05	0·72	–	4	5	2	2	4
			1/4	Grey Forge	7·166	25,380	·012	7,751	·142	7,711	8·3	99,193	0·89	1·41	2·74	–	0·03	0·95	–	16	19	16	3	17
			1/5	No. 4. Strong Forge	7·117	19,847	·010	7,173	·159	6,403	8·7	75,318	0·94	1·53	2·57	–	0·05	0·70	–	37	39	30	17	43
NORTH STAFFORDSHIRE	Goldendale Iron Works	7	17/1	Pig Iron	7·096	25,430	·008	7,591	·132	6,837	4·5	113,459	0·98	2·71	2·54	–	0·04	1·07	–	41	18	21	13	8
SOUTH STAFFORDSHIRE	Netherton Iron Works, near Dudley	8	2/1	No. 1. Melting Foundry Pig Iron	7·125	20,517	·010	6,954*	·166	6,130	14·4	73,977	0·96	1·48	3·07	–	0·03	0·43	–	35	37	33	26	45
			2/2	No. 2. Melting Foundry Pig Iron	7·175	26,012	·011	8,139	·196	7,186	14·9	86,473	0·80	1·27	3·04	–	0·04	0·34	–	14	14	7	9	32
			2/3	No. 3. Grey Forge	7·161	24,222	·012	7,634	·177	6,204	14·5	82,406	0·94	1·16	3·12	–	0·05	0·44	–	19	23	19	24	35
			2/4	No. 4 and 5. Forge	7·217	30,344	·014	9,619	·200	7,570	14·1	108,285	0·27	0·83	3·03	–	0·04	0·31	–	5	3	1	5	10
			2/5	No. 5. Strong Forge †	–	–	–	–	8,129	·123	–	–	–	0·13	0·57	2·81	–	0·06	0·29	–	–	–	8	–	–
	Park Head Furnaces, Dudley	9	10/1	Foundry Melting Pig	7·195	27,033	·011	7,778*	·168	7,226*	16·2	95,787	0·55	0·96	2·89	–	0·06	0·58	–	9	9	15	8	19
			10/2	Grey Forge	7·082	18,831	·010	5,998	·144	5,969	10·6	69,733	0·95	1·63	2·90	–	0·03	0·55	–	44	41	44	28	47
			10/3	Forge	7·193	30,554	·013	8,840*	·183	7,697*	11·7	107,223	0·86	1·21	3·00	–	0·10	0·48	–	10	2	5	4	11
	Old Hill Furnaces, near Dudley	10	7/1	No. 2. Foundry Pig	6·949	14,593	·009	5,192*	·133	4,642*	10·1	50,499	0·30	3·48	3·06	–	0·03	0·38	–	50	48	49	46	51
			7/2	No. 3. Grey Forge	7·111	23,815	·011	7,478	·167	7,147	13·5	80,991	0·34	2·24	2·69	–	0·04	0·63	–	39	26	24	10	38
			7/3	No. 4. Forge	7·058	22,918*	·012	6,926	·157	5,757*	8·5	80,213	trace	1·75	2·76	–	0·07	0·55	–	47	32	35	34	39
			7/4	Strong Forge	7·143	27,676*	·011	7,793*	·153	5,861*	6·1	119,807	0·54	1·36	2·55	0·25	0·11	0·41	–	27	8	13	33	5
	Lays Iron Works, near Dudley	11	16/1	Hematite Iron, first melting	7·253	31,480*	·012	8,142*	·171	5,071*	5·1	119,631	1·14	1·05	3·15	–	0·05	0·29	–	2	1	6	43	6
	Level Iron Works, Brierley Hill	12	12/1	Hot-blast Pig Iron	7·143	26,198	·013	7,254*	·145	5,879*	5·7	99,795	0·49	1·40	2·61	–	0·04	0·72	–	28	13	27	31	14
			12/2	Cold-blast Pig Iron	7·052*	25,872	·013	6,903*	·129	5,654*	6·2	86,650*	0·06	1·75	2·56	–	0·05	0·63	–	48	15	36	37	3
NORTHAMPTONSHIRE	East End Works, Wellingborough	13	9/1	No. 1. Grey Foundry Pig	7·185	20,105	·008	5,744	·107	5,424*	3·4	105,395	0·24	1·92	2·85	–	0·10	1·19	–	11	38	45	41	1
			9/2	No. 2. Mottled Iron †	–	–	–	–	4,869	·082	–	–	–	0·08	2·11	2·10	–	0·13	1·07	–	–	–	51	–	
	Heyford Iron Works, near Weedon	14	18/1	Pig Iron, first melting	[illegible]				·002	3,075	·082	3,905	1·9	77,690	trace	4·63	2·64	–	0·07	1·31	–	51	51	53	49	41
FOREST OF DEAN	Park End Furnaces, Gloucestershire	15	4/1	Foundry Pig	7·115	12,593	·009	5,220	·180	4,478	11·5	56,116	0·23	2·34	3·26	–	0·04	0·14	–	38	50	48	47	49
			4/2	Grey Forge	7·176	17,019	·009	6,781	·167	6,232	10·5	73,400	0·14	2·18	3·08	–	0·06	0·14	–	13	46	37	23	46
	Ystalyfera Iron Works, Glamorganshire	16	3/1	No. 1. Foundry Pig, Anthracite, Second Melting	7·165	25,172*	·011	7,848*	·163	6,704*	12·2	87,475*	0·27	1·87	3·27	–	0·05	0·41	–	17	21	11	14	27
			3/2	No. 2. Foundry Pig, Anthracite, Second Melting	7·157	26,758*	·013	7,944*	·196	6,176*	9·6	90,894	0·39	1·73	2·92	–	0·06	0·29	–	22	11	10	25	22
			3/3	No. 3. Foundry Pig, Anthracite, Second Melting	7·150	24,533	·012	7,228*	·166	5,719*	8·8	88,772	0·27	1·71	2·61	–	0·05	0·38	–	24	22	28	35	24
			3/4	No. 1. Foundry Pig, Anthracite, First Melting	7·132	25,311*	·013	7,656*	·174	6,265*	12·4	87,570	0·32	1·58	3·17	–	0·05	0·42	–	33	20	18	22	26
			3/5	No. 2. Foundry Pig, Anthracite, First Melting	7·132	21,661	·012	7,206*	·175	6,559*	12·1	77,573	0·14	2·07	2·55	–	0·09	0·38	–	32	36	29	15	42
			3/6	No. 3. Foundry Pig, Anthracite, First Melting	7·153	23,707	·012	7,785	·188	6,894	13·3	85,094	0·43	1·55	3·16	–	0·06	0·27	–	23	27	14	12	33
SOUTH WALES	Blaenavon Iron Works, Monmouthshire	17	14/1	No. 1. and C. Forge	7·163*	26,766*	·011	7,947*	·182	5,487*	6·1	105,203	0·53	0·81	2·82	–	0·06	0·38	–	18	10	9	40	13
			14/2	No. 1. Cold-blast Iron	7·137	25,456	·012	7,493*	·171	5,034*	9·0	91,897*	0·28	1 36	3·40	–	0·07	0·29	–	30	17	23	44	20
			14/3	Common Forge	7·268	28,637*	·009	7,805*	·144	5,953*	4·4	130,860	0·66	1·68	2·64	–	0·08	0·27	–	1	7	12	30	1
			14/4	No. 3. Cold-blast Iron	7·158	23,903*	·011	7,600*	·191	5,674*	10·2	87,358*	0·66	1·09	2·88	–	0·08	0·38	–	20	25	20	36	28
			14/5	Bright	7·150	23,139*	·009	6,594*	·120	3,882*	2·9	126,086	–	–	–	–	–	–	–	25	31	40	50	2
	Pontypool Iron Works, Monmouthshire	18	13/1	Cold-blast Iron	7·169	26,302*	·015	6,669*	·144	5,235*	5·3	99,618	0·42	1·46	2·42	–	0·12	0·32	–	15	12	39	42	15

Samples marked thus * (*) have one or more defective specimens in the set; for particulars, see preceding Tables,
† (†) too hard for turning.

Iron tested at the Royal Gun Factories, Woolwich.

MEAN RESULTS, ARRANGED ACCORDING TO THE ORDER OF STRENGTH.

No.	Specific Gravity. Foundry.	Mark.	Specific Gravity.
1	Blaenavon	14/3	7·268
2	Lays Works	16/1	7·253
3	Weardale	19/3	7·248
4	Ilkeston	1/3	7·239
5	Netherton	2/4	7·217
6	Ilkeston	1/2	7·217
7	Hematite	11/2	7·214
8	- ditto	11/3	7·196
9	Parkhead	10/1	7·195
10	- ditto	10/3	7·193
11	East End Works	9/1	7·185
12	Weardale	19/4	7·180
13	Forest of Dean	4/2	7·176
14	Netherton	2/2	7·175
15	Pontypool	13/1	7·169
16	Ilkeston	1/4	7·166
17	Ystalyfera	3/1	7·165
18	Blaenavon	14/1	7·163*
19	Netherton	2/3	7·161
20	Blaenavon	14/4	7·158
21	Weardale	19/2	7·158
22	Ystalyfera	3/2	7·157
23	- ditto	3/6	7·153
24	- ditto	3/3	7·150
25	Blaenavon	14/5	7·150
26	Stockton	15/1	7·148
27	Old Hill	7/4	7·143
28	Level Works	12/1	7·143
29	Butterley	8/1	7·141
30	Blaenavon	14/2	7·137
31	Stockton	15/2	7·135
32	Ystalyfera	3/5	7·132
33	- ditto	3/4	7·132
34	Butterley	8/3	7·126
35	Netherton	2/1	7·125
36	Ilkeston	1/1	7·121
37	- ditto	1/5	7·117
38	Forest of Dean	4/1	7·115
39	Old Hill	7/2	7·111
40	Hematite	11/1	7·097
41	Goldendale	17/1	7·096
42	South Bank	6/1	7·089
43	Weardale	19/1	7·088
44	Parkhead	10/2	7·082
45	Butterley	8/2	7·078
46	- ditto	8/4	7·073
47	Old Hill	7/3	7·058
48	Level Works	12/2	7·052*
49	South Bank	6/2	7·023
50	Old Hill	7/1	6·949
51	Heyford Works	18/1	6·886
	Netherton †	2/5	- -
	East End Works †	9/2	- -

No.	Tensile. Foundry.	Mark.	Breaking Weight.	Extension.
1	Lays Works	16/1	31,480*	·012
2	Parkhead	10/3	30,554	·013
3	Netherton	2/4	30,344	·014
4	Weardale	19/4	30,333	·012
5	Ilkeston	1/3	30,115*	·013
6	- ditto	1/2	29,840	·014
7	Blaenavon	14/3	28,637*	·009
8	Old Hill	7/4	27,676*	·011
9	Parkhead	10/1	27,033	·011
10	Blaenavon	14/1	26,766*	·011
11	Ystalyfera	3/2	26,758*	·013
12	Pontypool	13/1	26,302*	·015
13	Level Works	12/1	26,198	·013
14	Netherton	2/2	26,012	·011
15	Level Works	12/2	25,872	·013
16	Stockton	15/1	25,810	·011
17	Blaenavon	14/2	25,456	·012
18	Goldendale	17/1	25,430	·008
19	Ilkeston	1/4	25,380	·012
20	Ystalyfera	3/4	25,311*	·013
21	- ditto	3/1	25,172*	·011
22	- ditto	3/3	24,533	·012
23	Netherton	2/3	24,222	·012
24	Butterley	8/4	24,126*	·010
25	Blaenavon	14/4	23,903*	·011
26	Old Hill	7/2	23,815	·011
27	Ystalyfera	3/6	23,707	·012
28	Weardale	19/3	23,513*	·009
29	Butterley	8/1	23,388	·010
30	- ditto	8/3	23,265	·009
31	Blaenavon	14/5	23,139*	·009
32	Old Hill	7/3	22,918*	·012
33	Stockton	15/2	22,271	·009
34	Ilkeston	1/1	22,107	·012
35	Weardale	19/2	21,859*	·011
36	Ystalyfera	3/5	21,661	·012
37	Netherton	2/1	20,517	·010
38	East End Works	9/1	20,105	·008
39	Ilkeston	1/5	19,847	·010
40	Butterley	8/2	18,970	·010
41	Parkhead	10/2	18,831	·010
42	South Bank	6/1	18,425	·008
43	Weardale	19/1	18,080	·010
44	Hematite	11/2	17,751*	·012
45	- ditto	11/3	17,566*	·012
46	Forest of Dean	4/2	17,019	·009
47	South Bank	6/2	15,835	·006
48	Old Hill	7/1	14,593	·009
49	Hematite	11/1	14,233	·011
50	Forest of Dean	4/1	12,593	·009
51	Heyford Works	18/1	10,866	·002
	Netherton †	2/5	- -	-
	East End Works †	9/2	- -	-

No.	Transverse. Foundry.	Mark.	Breaking Weight.	Deflection.
1	Netherton	2/4	9,619	·200
2	Ilkeston	1/3	9,399	·157
3	- ditto	1/2	9,033	·172
4	Weardale	19/4	8,948	·191
5	Parkhead	10/3	8,840*	·183
6	Lays Works	16/1	8,142*	·171
7	Netherton	2/2	8,139	·196
8	- ditto	2/5	8,129	·123
9	Blaenavon	14/1	7,947*	·182
10	Ystalyfera	3/2	7,944*	·196
11	- ditto	3/1	7,848*	·163
12	Blaenavon	14/3	7,805*	·144
13	Old Hill	7/4	7,793*	·153
14	Ystalyfera	3/6	7,785	·188
15	Parkhead	10/1	7,778*	·168
16	Ilkeston	1/4	7,751	·142
17	Weardale	19/3	7,672*	·173
18	Ystalyfera	3/4	7,656*	·174
19	Netherton	2/3	7,634	·177
20	Blaenavon	14/4	7,600*	·191
21	Goldendale	17/1	7,591	·132
22	Ilkeston	1/1	7,587	·153
23	Blaenavon	14/2	7,493*	·171
24	Old Hill	7/2	7,478	·167
25	Weardale	19/2	7,374*	·181
26	Butterley	8/4	7,364*	·153
27	Level Works	12/1	7,254*	·145
28	Ystalyfera	3/3	7,228*	·166
29	- ditto	3/5	7,206*	·175
30	Ilkeston	1/5	7,173	·159
31	Stockton	15/1	7,159	·136
32	Butterley	8/1	7,106	·145
33	Netherton	2/1	6,954*	·166
34	Stockton	15/2	6,932	·134
35	Old Hill	7/3	6,926	·157
36	Level Works	12/2	6,903*	·129
37	Forest of Dean	4/2	6,781	·167
38	Butterley	8/3	6,692	·130
39	Pontypool	13/1	6,669*	·144
40	Blaenavon	14/5	6,594*	·120
41	South Bank	6/1	6,260	·110
42	Hematite	11/3	6,100*	·152
43	Butterley	8/2	6,077	·128
44	Parkhead	10/2	5,998	·144
45	East End Works	9/1	5,744	·107
46	Weardale	19/1	5,600*	·147
47	South Bank	6/2	5,563	·105
48	Forest of Dean	4/1	5,220	·180
49	Old Hill	7/1	5,192*	·133
50	Hematite	11/2	5,105*	·120
51	East End Works	9/2	4,869	·082
52	Hematite	11/1	4,644	·161
53	Heyford Works	18/1	3,075	·082

No.	Torsion. Foundry.	Mark.	Breaking Weight.	Angle of Torsion.
1	Ilkeston	1/2	8,113*	8·0
2	- ditto	1/3	7,973*	8·6
3	- ditto	1/4	7,711	8·3
4	Parkhead	10/3	7,697*	11·7
5	Netherton	2/4	7,570	14·1
6	Butterley	8/1	7,342	9·3
7	Ilkeston	1/1	7,312	8·1
8	Parkhead	10/1	7,226*	16·2
9	Netherton	2/2	7,186	14·9
10	Old Hill	7/2	7,147	13·5
11	Butterley	8/3	6,940	7·5
12	Ystalyfera	3/6	6,894	13·3
13	Goldendale	17/1	6,837	4·5
14	Ystalyfera	3/1	6,704*	12·2
15	- ditto	3/5	6,559*	12·1
16	South Bank	6/1	6,405	5·7
17	Ilkeston	1/5	6,403	8·7
18	Butterley	8/4	6,371*	6·4
19	Weardale	19/3	6,350	7·2
20	Stockton	15/2	6,305	5·7
21	Weardale	19/4	6,277*	5·2
22	Ystalyfera	3/4	6,265*	12·4
23	Forest of Dean	4/2	6,232	10·5
24	Netherton	2/3	6,204	14·5
25	Ystalyfera	3/2	6,176*	9·6
26	Netherton	2/1	6,130	14·4
27	Butterley	8/2	6,011	7·5
28	Parkhead	10/2	5,969	10·6
29	Weardale	19/2	5,968*	7·7
30	Blaenavon	14/3	5,953*	4·4
31	Level Works	12/1	5,879*	5·7
32	Stockton	15/1	5,872*	4·2
33	Old Hill	7/4	5,861*	6·1
34	- ditto	7/3	5,757*	8·5
35	Ystalyfera	3/3	5,719*	8·8
36	Blaenavon	14/4	5,674*	10·2
37	Level Works	12/2	5,654*	6·2
38	South Bank	6/2	5,626	6·5
39	Weardale	19/1	5,510	10·1
40	Blaenavon	14/1	5,487*	6·1
41	East End Works	9/1	5,424*	3·4
42	Pontypool	13/1	5,235*	5·3
43	Lays Works	16/1	5,071*	5·1
44	Blaenavon	14/2	5,034*	9·0
45	Hematite	11/3	4,977*	4·9
46	Old Hill	7/1	4,642*	10·1
47	Forest of Dean	4/1	4,478	11·5
48	Hematite	11/2	4,182*	5·8
49	Heyford Works	18/1	3,905	1·9
50	Blaenavon	14/5	3,882*	2·9
51	Hematite	11/1	3,724*	7·2
	Netherton †	2/5	- -	-
	East End Works †	9/2	- -	-

No.	Crushing. Foundry.	Mark.	Breaking Weight.
1	Blaenavon	14/3	130,860
2	- ditto	14/5	126,086
3	Weardale	19/4	122,216
4	Ilkeston	1/3	120,321
5	Old Hill	7/4	119,807
6	Lays Works	16/1	119,631
7	Ilkeston	1/2	119,483
8	Goldendale	17/1	113,459
9	Weardale	19/3	109,286
10	Netherton	2/4	108,285
11	Parkhead	10/3	107,223
12	East End Works	9/1	105,395
13	Blaenavon	14/1	105,203
14	Level Works	12/1	99,795
15	Pontypool	13/1	99,618
16	Stockton	15/1	99,524
17	Ilkeston	1/4	99,193
18	Butterley	8/4	97,041
19	Parkhead	10/1	95,787
20	Blaenavon	14/2	91,897*
21	Butterley	8/3	91,661
22	Ystalyfera	3/2	90,894
23	Weardale	19/2	90,046*
24	Ystalyfera	3/3	88,772
25	Butterley	8/1	88,488
26	Ystalyfera	3/4	87,570
27	- ditto	3/1	87,475*
28	Blaenavon	14/4	87,358*
29	Stockton	15/2	87,063
30	South Bank	6/1	86,886
31	Level Works	12/2	86,650*
32	Netherton	2/2	86,473
33	Ystalyfera	3/6	85,094
34	Hematite	11/3	82,583
35	Netherton	2/3	82,406
36	Hematite	11/2	82,265
37	Ilkeston	1/1	82,229*
38	Old Hill	7/2	80,991
39	- ditto	7/3	80,213
40	South Bank	6/2	77,926
41	Heyford Works	18/1	77,690
42	Ystalyfera	3/5	77,573
43	Ilkeston	1/5	75,318
44	Butterley	8/2	74,743
45	Netherton	2/1	73,977
46	Forest of Dean	4/2	73,400
47	Parkhead	10/2	69,733
48	Weardale	19/1	59,771
49	Forest of Dean	4/1	56,116
50	Hematite	11/1	52,136
51	Old Hill	7/1	50,499
	Netherton †	2/5	—
	East End Works †	9/2	—

TABLE B., showing the Comparative Effects produced by different Modes of CASTING and COOLING.

No.	FOUNDRY.	Mark.	HIGHEST SAMPLES IN MODE OF CASTING.										HIGHEST SAMPLES IN MANNER OF COOLING.															
			Specific Gravity.		Tensile.		Transverse.		Torsion.		Crushing.		Specific Gravity.			Tensile.			Transverse.			Torsion.			Crushing.		
			Horizontal.	Vertical.	Horizontal.	Vertical.	Horizontal.	Vertical.	Horizontal.	Vertical.	Horizontal.	Vertical.	Slow.	Gradual.	Quick.	Slow.	Gradual.	Quick.	Slow.	Gradual.	Quick.	Slow.	Gradual.	Quick.	Slow.	Gradual.	Quick.
1	Hematite Foundry	11/1	–	1	–	1	–	1	–	1	–	1	–	1	–	–	1	–	–	–	1	1	–	–	1	–	–
2		11/2	1	–	1	–	–	1	–	1	–	1	–	–	1	1	–	–	1	–	–	1	–	–	1	–	–
3		11/3	1	–	1	–	1	–	1	–	1	–	–	1	–	–	–	1	–	1	–	1	–	–	1	–	–
4	Weardale Iron Company	19/1	1	–	–	1	1	–	1	–	1	–	–	1	–	–	–	1	–	–	1	–	–	1	–	1	–
5		19/2	–	1	1	–	1	–	–	1	1	–	1	–	–	1	–	–	–	1	–	–	–	1	1	–	–
6		19/3	1	–	1	–	1	–	1	–	–	–	–	–	1	–	–	1	–	–	1	–	–	1	–	–	1
7		19/4	1	–	1	–	1	–	1	–	1	–	–	–	1	1	–	–	–	–	1	1	–	–	–	–	1
8	South Bank Furnaces	6/1	1	–	–	1	1	–	–	1	1	–	–	–	1	–	–	1	1	–	–	–	–	1	–	–	1
9		6/2	–	1	–	1	1	–	–	1	1	–	–	1	–	–	–	1	–	–	1	–	–	1	–	–	1
10	Stockton Iron Works	15/1	1	–	1	–	1	–	–	1	1	–	–	–	1	–	–	1	–	–	1	–	–	1	–	–	1
11		15/2	1	–	1	–	1	–	–	1	1	–	–	1	–	–	–	1	1	–	–	–	–	1	1	=	1
12	Butterley Iron Works	8/1	1	–	–	1	1	–	–	1	–	1	–	–	1	–	–	1	1	–	–	–	–	1	–	–	1
13		8/2	–	1	–	1	1	–	–	1	–	1	1	=	1	–	1	–	–	–	1	–	1	–	–	–	1
14		8/3	1	–	1	–	1	–	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	1	–	–	1
15		8/4	1	–	1	–	1	–	1	–	1	–	1	–	–	–	–	1	–	–	1	–	–	1	–	–	1
16	West Hallum Iron Works	1/1	–	1	1	–	1	–	1	–	1	–	–	1	–	–	–	1	–	–	1	–	–	1	–	–	1
17		1/2	1	–	1	–	1	–	1	–	1	–	1	–	–	1	–	–		1	–	–	–	1	1	–	–
18		1/3	–	1	1	–	1	–	1	–	1	–	–	–	1	–	1	–	–	–	1	–	1	–	–	–	1
19		1/4	1	–	1	–	1	–	–	1	1	–	–	–	1	1	–	–	–	1	–	–	–	1	–	–	1
20		1/5	–	1	–	1	1	–	1	–	1	–	–	1	–	–	–	1	–	1	–	–	–	1	–	1	–
21	Goldendale Iron Works	17/1	–	1	1	–	1	–	–	1	1	–	–	–	1	–	1	–	–	1	–	1	–	–	–	–	1
22	Netherton Iron Works	2/1	1	–	1	–	1	–	–	1	1	–	–	–	1	–	–	1	–	–	1	–	–	1	–	–	1
23		2/2	–	1	–	1	1	–	–	1	1	–	–	–	1	–	–	1	–	1	–	–	1	–	–	–	1
24		2/3	1	–	1	–	1	–	–	1	1	–	1	–	–	–	–	1	–	–	1	–	1	–	–	–	1
25		2/4	1	–	1	–	1	–	1	–	1	–	1	–	–	–	–	1	–	1	–	–	1	–	–	–	1
26		2/5	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
27	Park Head Furnaces	10/1	1	–	1	–	1	–	1	–	–	1	1	–	–	–	–	1	1	–	–	1	–	–	–	–	1
28		10/2	1	–	1	–	1	–	–	1	1	–	–	1	–	–	–	1	–	–	1	–	–	1	–	–	1
29		10/3	1	–	1	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	1	–	–	1	–	–	1
30	Old Hill Furnaces	7/1	1	–	1	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	1	–	–	1	–	–	1
31		7/2	1	–	1	–	1	–	–	1	–	1	1	–	–	–	–	1	–	–	1	–	–	1	–	–	1
32		7/3	–	1	1	–	1	–	1	–	–	1	1	–	–	–	–	1	1	–	–	–	–	1	–	–	1
33		7/4	1	–	1	–	1	–	1	–	–	1	–	–	1	–	–	1	–	–	1	1	=	1	–	1	–	–
34	Lay's Iron Works	16/1	1	–	1	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	1	1	–	–	–	–	–	1
35	Level Iron Works	12/1	1	–	1	–	1	–	–	1	1	–	–	–	1	–	–	1	–	–	1	1	–	–	–	–	–	1
36		12/2	–	1	1	–	1	–	–	1	1	–	1	–	–	–	1	–	1	–	–	1	–	–	–	–	–	1
37	East End Works	9/1	1	–	1	–	1	–	–	1	1	–	–	1	–	1	–	–	–	–	1	1	–	–	1	=	1	–
38		9/2	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
39	Heyford Iron Works	18/1	1	–	1	–	1	–	1	–	–	–	–	1	–	1	–	–	–	–	1	–	–	1	–	1	–
40	Park End Furnaces	4/1	1	–	1	–	1	–	1	–	–	1	–	1	–	–	–	1	–	1	–	–	–	1	–	–	1
41		4/2	–	1	–	1	1	–	1	–	–	–	–	1	–	–	1	–	–	–	1	1	–	–	–	–	1
42	Ystalyfera Iron Works	3/1	1	–	1	–	1	–	1	–	–	1	–	–	1	–	1	–	–	1	–	–	1	–	–	–	1
43		3/2	1	–	1	–	1	–	1	–	–	1	–	1	–	–	1	–	–	1	–	–	–	–	–	–	1
44		3/3	1	–	1	–	1	–	–	1	1	–	1	–	–	–	–	1	1	–	–	1	–	–	–	1	–
45		3/4	1	–	1	–	1	–	1	–	–	1	–	1	–	1	–	–	–	1	–	–	–	–	–	–	1
46		3/5	1	–	1	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	1	–	–	1	–	1	–
47		3/6	–	1	1	–	1	–	–	1	1	–	1	–	–	–	–	1	–	–	1	–	1	–	–	–	1
48	Blaenavon Iron Works	14/1	1	–	1	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	1	–	–	–	–	–	1
49		14/2	1	–	1	–	1	–	1	–	1	–	–	1	–	–	–	1	–	1	–	1	–	–	–	1	–
50		14/3	1	–	1	–	1	–	–	1	–	1	–	1	–	1	–	–	1	–	–	–	–	–	–	–	1
51		14/4	1	–	1	–	1	–	–	1	1	–	1	–	–	–	–	1	–	–	1	–	–	1	–	1	–
52		14/5	1	–	1	–	1	–	1	–	–	–	–	1	–	1	–	–	1	–	–	–	–	1	–	–	–
53	Pontypool Iron Works	13/1	1	–	1	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	1	–	1	–	–	–	–
	TOTAL		38	13	42	9	50	3	27	24	33	14	13	18	21	10	8	33	12	13	28	16	10	26	10	8	35
	RATIO (nearly)		3 : 1		5 : 1		17 : 1		9 : 8		5 : 2		4 : 6 : 7			5 : 4 : 16			1 : 1 : 2			8 : 5 : 13			2 : 2 : 7		

REMARKS explanatory of the course adopted in the Chemical Examination of the IRON SAMPLES, and of the Materials employed in their Manufacture.

IN conducting a large series of analytical examinations of a quantitative character, which have been undertaken, not simply to furnish results of scientific interest, but with a view to be of use in considerations of a practical character, it is not only admissible, but necessary that some discrimination should be exercised in determining the extent of detail of such examinations, so that, on the one hand, a proper knowledge be obtained of the proportions of all the important and characteristic components of a substance, while on the other hand, no great unnecessary expenditure of time and labour be incurred in researches on the existence or proportions of constituents which occur in minute quantities in the substances examined, and have not yet been discovered to exert any influence on its chemical or physical character.

Thus, the existence in cast-iron of metals, such as titanium, calcium, magnesium, nickel, copper, lead, &c. has been traced by minute analyses of various samples by different chemical authorities, and the proportions in which they occur have also frequently been determined; but it is only when some foreign metal, such as copper, lead or arsenic, has been found to exist in a sample of cast-iron in a larger proportion than usual, that it has been proved to exert some marked and well-established influence over the character of the metal.

It may, therefore, be safely inferred, in the present state of our knowledge, that modifications in the properties of cast-iron are not dependent upon the presence or absence of minute proportions of such foreign metals, and that researches, having in view the discovery or the determination of the proportions of these constituents, do not, at present, possess any practical interest, and are only advisable:

1. In conducting analyses of specimens of peculiar interest, for purposes of scientific record.

2. In undertaking special researches, with a view to ascertain whether, and to what extent, these constituents influence the properties of cast-iron.

Such researches as those last referred to, are unquestionably of great interest, and if pursued to a sufficient extent, may possibly lead hereafter to important practical results. Their objects differ, however, from those of the investigation the results of which are embodied in this report, and which was undertaken with a view to ascertain, by an application of *our present knowledge* of the chemical and physical properties of cast-iron, the relative qualities of various descriptions of pig-iron submitted by numerous manufacturers.

There is no question, however, that it is in most instances very important to perform complete analyses of materials which are to be employed for the extraction of metals. For as these, at the high temperature necessary in the process of their reduction from ores, are endowed with powerful affinities for many of the frequent constituents of such ores, their properties will suffer more or less important modification, by union with some of these components in the course of their reduction.

The quality of the product may therefore be, to some extent (when the treatment is under control), predicted from the results of a complete examination of the materials employed. It is, consequently, not only essential to ascertain the general composition of an ore, for the purpose of determining the nature and proportions of the auxiliary materials (fluxes) to be associated with it in the reduction process, but it is also of considerable importance to ascertain whether, and in what proportions, such constituents (as foreign metals, sulphur and phosphorus) are contained in the ores, as are likely to enter into the composition of the product, and exert an influence upon its properties.

In the chemical examination of the large series of iron samples and materials employed in their manufacture, the system of analysis adopted has been based upon the principles embodied in the foregoing remarks.

The analyses have been performed by Mr. John Spiller, formerly Chemical Assistant at the Royal College of Chemistry, and subsequently at the Government School of Mines, and Mr. Arthur Reynolds, late an assistant at the College of Chemistry.

The samples of ores received from the manufacturers have been all submitted to complete analysis, excepting in the following instances:

1. In one or two cases, where the samples were found to be identical in character with some of the series of ores recently submitted to complete analysis at the Government School of Mines, under Dr. Percy, the results of which have been published in the "Memoirs of the Geological Survey of Great Britain."

The close resemblance of the samples to those above alluded to, was established by a comparison with the descriptions given of the ores in the Government Report; by a careful examination of them made by Mr. Spiller, who performed a large number of the analyses alluded to in that report, while at the School of Mines, and was well acquainted with all the specimens examined; and, lastly, by a determination of the most important constituents

of the samples received (*e. g.* the oxide of iron and phosphoric acid), and a comparison of the results with those of the published analyses.

In these instances, as a complete analysis of the samples would have involved a very considerable unnecessary expenditure of time, it was not undertaken; but the detailed analyses of the ores, to which the samples corresponded, have been extracted from the Government Report.

2. A few of the ores received had been submitted to the roasting process. As the effect of this treatment of an ore is greatly to modify its original composition, partially expelling certain constituents, and altering the arrangement and state of combination of others, a detailed analysis would afford no correct indication of the original nature of the ore. In such instances, therefore, it was only considered important to determine the per-centages of iron and of those constituents which might affect the quality of the metal obtained from the ore;—the phosphoric acid and sulphur.

3. The ores sent by some manufacturers were identical in their nature with those from other works, and of which complete analyses have been made. In these instances, the most important constituents of the samples in question have alone been determined, references having been made when needful to the full analyses.

The minerals employed as fluxes were all submitted to complete analysis, except in one or two instances, when their identity with samples already analysed, was established by the determination of one or two constituents.

The examination of the fuel was partial, the only important object being to determine to what extent it might contain mineral matters possibly prejudicial to the quality of the metal reduced by its means. The examinations therefore included determinations of the amount of sulphur in the coal or coke, and the amount and character of the ash furnished by incineration. It was also considered interesting to determine the amount of coke furnished by the different samples of coal.

The analyses of the samples of iron were, for the reasons already stated, limited in most instances to the determination of the proportions of those constituents which have already been satisfactorily proved to exert some influence on the quality of the pig-iron, or on the results obtained by submitting it to subsequent processes of manufacture.

The constituents in question are manganese, silicon, phosphorus, sulphur, and carbon.

With reference to the last-named substance, it may be necessary to observe, that almost all the specimens of pig-iron examined which are included in this Report, were varieties of grey-iron, and that but very few of the samples contained any appreciable amount of carbon in the combined form.

It was, therefore, of no importance or interest to determine the minute portions of carbon existing in the samples in the latter form, and this was proved by special examinations of a few of the light grey samples of the series, in which the amount of combined carbon was not found to exceed at highest 0·35 per cent.; and also by the determination of the total amount of carbon in a sample of No. 1 pig-iron, the result obtained being identical with that afforded by the direct estimation of the carbon existing as graphite.

In two or three instances, it was considered interesting to examine specially for certain foreign metals which had been found to exist in appreciable quantities in some of the ores from which the samples thus examined had been obtained.

Description of the Analytical Processes employed in the Chemical Examination of the Irons, Ores, Fuels, and Fluxes.

I.—Analyses of the Iron Samples.

Preparation of the Sample.—Preparatory to its examination, the metal was reduced to a suitable state of division by boring, turning, or planing; in the case of white iron, it was broken to a coarse powder in a steel crushing mortar. It was considered preferable to prepare an average sample of the pig by boring across it, so that a fair proportion of the graphite, which was occasionally concentrated towards the centre of the pig, might be included in the sample. The fine borings obtained in this way were further reduced, when necessary, and thoroughly mixed by trituration in a Wedgwood mortar.

Chemical Analysis.—In the analysis of pig-iron, the proportion of the following constituents were usually determined: manganese, carbon, silicon, sulphur, phosphorus, and, in certain cases, metals such as arsenic, lead, and copper, when their existence in appreciable quantity had been discovered in the ores from which the iron had been obtained.

For this purpose, four portions were usually weighed out:

a. 100 grains, for sulphur, carbon existing as graphite, silicon, and manganese.
b. 50 grains, for phosphorus.
c. 50 to 100 grains, for determining the existence and amount of combined carbon.
d. 500 grains, for metals existing in the iron in minute proportions.

Sulphur.—One hundred grains of the iron borings were slowly dissolved in concentrated hydrochloric acid, the evolved gas being passed through a solution of acetate of lead, slightly acidified with acetic acid, the sulphuretted hydrogen, disengaged together with hydrogen, precipitated the sulphide of lead, which was collected on a filter, washed, burnt, and subsequently (in the customary manner) converted into sulphate of lead, from the weight of which the per-centage of sulphur was calculated.

The contents of the flask, after the metal had been fully acted upon, were transferred to a porcelain basin, and evaporated to dryness, the mass digested with concentrated hydrochloric acid, and water afterwards added. The insoluble residue, consisting of silicic acid and graphite, was collected on a filter, the filtrate being reserved for the estimation of manganese.

Carbon, as Graphite.—The mixed silicic acid and graphite were separated by the action of a warm solution of pure potassa, when the silicic acid was dissolved, the graphite which remained insoluble was again collected, washed with dilute hydrochloric acid and water, and dried; it was afterwards carefully removed from the paper by scraping with a knife-blade, and transferred to a platinum crucible, in which, after exposure for some time to about 300° F., it was weighed. Upon subsequently burning the graphite in a muffle, it usually left a very small quantity of reddish ash, which was deducted from the former weight.

Silicon.—The amount of silicic acid, dissolved by the potassa, was recovered in the usual manner, by evaporation with hydrochloric acid; the residue was digested with water, collected, washed, dried, and weighed. The amount of the silicon in the iron was calculated from the silicic acid obtained.

Manganese.—The hydrochloric acid solution, separated from the silicic acid and graphite, was divided into two equal portions, one of which, representing 50 grains of iron, was always sufficient for the estimation of the manganese. The iron in the liquid having been peroxidised by boiling the hydrochloric acid solution, and adding occasionally a little chlorate of potassa, the acid was to a great extent neutralised, by addition of carbonate of ammonia. Sufficient acetate of ammonia was afterwards added for the conversion of the chloride of iron into acetate, and the liquid was boiled, when the iron was completely separated as insoluble basic acetate. The filtrate containing the manganese was rendered alkaline with ammonia, and, after the addition of a few drops of bromine, set aside for about 18 hours. The hydrated binoxide of manganese which had separated from the liquid, was afterwards collected, washed, dried, and ignited at a high temperature, when it was weighed as manganoso-manganic oxide ($Mn_3 O_4$), which furnished, by calculation, the quantity of manganese.

Phosphorus.—For the estimation of phosphorus, 50 grains of the iron borings were acted upon with warm nitro-hydrochloric acid, in a flask with a long neck, and, after complete solution of the metal, the contents of the flask were transferred to a porcelain basin, and evaporated to dryness; the residue was moistened with concentrated hydrochloric acid, and again evaporated, so as thoroughly to expel nitric acid. The residue then obtained was dissolved in hydrochloric acid, the solution diluted, filtered, nearly neutralised with carbonate of ammonia, and the iron in solution reduced to protoxide, by the addition of sulphite of ammonia to the gently heated liquid, and the subsequent careful addition of dilute sulphuric acid, to expel excess of sulphurous acid. Acetate of ammonia, and a few drops of solution of sesquichloride of iron were then added, and the liquid boiled, when the phosphoric acid was precipitated as basic phosphate of sesquioxide of iron, with some basic acetate. The liquid was rapidly filtered, with as little exposure to the air as possible, the precipitate was slightly washed and dissolved in hydrochloric acid, the solution neutralised with carbonate of ammonia, and a mixture of ammonia and sulphide of ammonium added; it was then gently heated, to ensure the conversion of the phosphate into sulphide of iron. The latter was afterwards removed by filtration, washed with dilute sulphide of ammonium, and the phosphoric acid was precipitated from the solution in the usual manner as ammonio-phosphate of magnesia, and weighed as pyrophosphate of magnesia, from the amount of which the phosphorus was calculated.

Combined Carbon.—After numerous comparative trials of the several methods in common use for determining the total amount of carbon in cast-iron, that which was ultimately adopted (after necessary experiments had fully established its accuracy) consisted in dissolving the metal in an acid solution of chloride of copper, collecting and washing the insoluble residue which remained after the complete action of this solvent, and submitting it, when dry, to combustion with oxide of copper in a current of oxygen—the source of heat employed being the gas combustion furnace. The total amount of carbon in the iron was then calculated from the weight of carbonic acid absorbed by solution of potassa in the usual manner. The carbon, existing in a state of combination with the iron, was represented by the excess which this process afforded over that of the direct estimation of the carbon as graphite, in the manner already described.

Minute proportions of Foreign Metals.—About 400 or 500 grains of the iron were employed in the examination for metals precipitated by sulphuretted hydrogen, *e. g.* lead, copper, arsenic, &c. The iron was dissolved in hydrochloric acid, and the solution, diluted and

partly neutralised with carbonate of soda, was submitted to the action of sulphuretted hydrogen. After saturation with the gas, the liquid was allowed to stand at rest for several hours, and the small quantity of sediment which had subsided was examined for metals by the ordinary analytical processes.

II.—Analysis of the Iron Ores.

The analytical processes employed for the separation of the various constituents occurring in iron ores were, in great measure, identical with those employed in the examination of metallic iron; thus—the estimation of oxide of manganese was conducted in a precisely similar manner; and, with the exception that no process of reduction was required in the case of clay ironstones and other ores containing the iron already in the state of protoxide, the phosphoric acid was determined by the same process as that employed for the estimation of phosphorus in pig-iron. The amount of metallic iron, and its condition of oxidation in the ore, were determined by Marguerritte's volumetrical method, with standard solution of permanganate of potassa; while the proportions of lime and magnesia, carbonic acid, water, hygroscopic and combined, insoluble residue, and the nature of this latter, were determined by following the analytical processes invariably employed in mineral analyses of this description.

Sulphur was estimated by fusion of the ore (or, in the case of clay ironstone, of the clay only), with a mixture of pure carbonate of soda and nitre; the sulphuric acid being precipitated by chloride of barium, from the acidified solution of the fused mass, and the sulphate of baryta collected, burnt and weighed as usual. The hydrochloric acid solution of the ironstone was examined for sulphuric acid, but it was seldom that more than a trace of sulphur was detected in that form.

III.—Analysis of the Samples of Fluxes.

These materials, consisting of limestone, burnt shale, &c., were analysed by a method precisely similar to that employed in the examination of the ores. In the tabulated statement, showing the composition of the limestones, the amount of carbonate of lime is, in some few instances, represented by the difference, after the whole of the other constituents had been determined. In such cases, the sum total of constituents is necessarily expressed by 100 exactly.

IV.—Analysis of the Samples of Fuel.

Sulphur.—For the estimation of sulphur, 20 grains of the finely powdered coal or coke were fused in a platinum basin, with 500 grains of a mixture of four parts of pure chloride of sodium, two of nitrate of potassa, and one of carbonate of soda. The filtered aqueous solution of the fused mass was acidulated, precipitated by chloride of barium, and the sulphate of baryta collected and weighed.

Ash.—The ash left on burning a weighed portion of the coal or coke was also determined, and its composition ascertained by qualitative examination.

RESULTS of the Chemical Examination of Iron, and Materials employed in its Production.

A special report has been drawn up on the results of the analytical examinations of each set of samples received from the various works.

To facilitate a comparison between the composition of the irons, ores, &c., tabulated statements have been prepared, of the following description:—

Table I. embraces the numerical results obtained in the examination of the samples of iron.

Table II. exhibits the per-centages of the most important constituents of the various ores; and,

Table III. includes, similarly, the principal results obtained in the examination of the fuels and fluxes.

The following are a few remarks which have suggested themselves upon an inspection of these tabulated results:—

The specimens of iron prepared from the ores of the Northern District and from the Forest of Dean, are remarkably free from phosphorus. This is readily explained by the very high quality of these ores, which are almost perfectly free from phosphoric acid. The considerable per-centage of silicon contained in a great number of the specimens of iron alluded to, is perhaps less easy of explanation. A reference to the composition of the specimen of Ulverston (Hæmatite) iron, given in the Appendix to this Report, which was smelted with charcoal, and only contains 0·59 per cent. of silicon, would appear, however, to indicate definitely that the high proportions of silicon must be ascribed to the employment of hot-blast in the reduction of the iron at those works.

The products of the ores from South Staffordshire and South Wales which have been examined are, with two or three exceptions, of excellent chemical quality. Only three instances occur in these divisions of the series of iron samples (out of 26 samples from eight different works), in which the amount of silicon reaches two per cent. The samples from the Netherton and Old Hill Works (South Staffordshire) and the Blaenavon and Pontypool Works (South Wales), in the preparation of which cold-blast is specified as having been employed, the silicon, in only two instances (out of 13 varieties of iron), slightly exceeds in amount 1·15 per cent.

The proportions of phosphorus and sulphur in irons from the ores of these districts are also inconsiderable in the majority of the samples examined. In the case of three only (out of 26) does the amount of sulphur reach to 1-10th per cent., and the phosphorus amounts to less than 0·5 per cent. in 20 instances; of the other six, three contain less than 0·6 per cent.; one from the Old Hill Works contains 0·63 per. cent., and two samples from Brierly Hill Works contain 0·63 and 0·72 per cent. The ores employed at the latter works contain somewhat high per-centages of phosphoric acid, the effects of which on the composition of the iron produced, are, therefore, clealy traced. The per-centages of phosphoric acid in the ores used at the Old Hill Works (particularly in the "Balls," Bilston), are also higher than those in most of the ores used at the remaining South Staffordshire Works, and its influence on the quality of the product is, to some extent, shown by a reference to the composition of some of the irons from those works.

That the proportion of phosphorus in the iron is not always determined by the proportion of phosphoric acid existing in the ore employed, need, however, be scarcely pointed out; the fact may be exemplified by reference to some of the samples of iron from the works last alluded to, and to the iron from the Lays Works, near Dudley, in which the per-centage of phosphorus is small, while the phosphoric acid in the ore is comparatively high. The circumstance that the proportion of phosphorus in all the samples of iron from the Blaenavon Works is small, while several of the ores employed contain considerable quantities of phosphoric acid, is probably to be ascribed to the employment of cold blast in the reduction of the iron at those works.

The oolitic ores and the clay ironstones employed at the works in the North Midland and North Staffordshire districts, from which specimens were submitted, as also the ochrey brown ironstones employed at the Northamptonshire Works, contain proportions of phosphoric acid, which are more considerable than those existing in the greater number of the other ores examined. Thus, the ore employed at the South Bank Furnaces contains nearly two per cent. of phosphoric acid; that used at the Stockton Works contains upwards of 1·5 per cent., and very nearly the same amount exists in one of the ores at the Butterley Works, and in that employed at the Goldendale Works (North Staffordshire). The proportions of phosphorus in the various samples of iron from these sources exceed one per cent., excepting in one sample from the Butterley Works, in which, however, it amounts to 0·72 per cent.

The samples of iron produced from Northamptonshire ores also contain more than one per cent. of phosphorus, the proportions of phosphoric acid in the ores are, however, not quite

quite as high as those last alluded to, amounting to 0·84 and 1·03 per cent. The samples of iron from one of the works (the East End Iron Works) are, moreover, stated to have been produced with cold blast.

The North Staffordshire ore, used at the Goldendale Works, contains nearly 1·5 per cent. of phosphoric acid, and the proportion of phosphorus in the iron produced from it, just exceeds one per cent.

A general inspection of the results obtained in the examination of the samples of ores and of the iron varieties produced from them, appears to justify the following conclusions, upon which metallurgic chemists are now tolerably well agreed:—

1° The proportion of silicon in iron is much less influenced by the constitution or quality of the ores employed, than by the conditions of smelting. A reference to the composition of the Northamptonshire ores and iron samples (particularly those from the Heyford Works), indicates that under certain circumstances, among which may probably be included a deficiency in alumina, in the ore or the flux employed, an ore containing much silica is very liable to furnish a highly siliceous iron.

2° The proportion of sulphur existing even in light grey pig-iron is never so considerable as to exert an appreciable influence on the properties of the metal; and none of the descriptions of British ores which have been examined in connexion with this Report contain an amount of sulphur compounds sufficient to exert any prejudicial influence on the quality of iron produced from them.

3° The proportion of phosphorus in iron is, in great measure, determined by the per-centage of phosphoric acid in the ore employed, while, at the same time, it is probably to some extent regulated by the temperature at which the reduction is effected (*i. e.* by the employment of hot or cold blast)

The various ores examined, if classed according to the per-centage of phosphorus in the iron reduced from them, would stand in the following order:

No. 1. Northern District and Forest of Dean ores, used by the Whitehaven, Weardale and Parkend Works.

No. 2. South Staffordshire ores, used at the Netherton, Parkhead, Old Hill, Lays and Level Works.

South Wales ores, used at the Ystalyfera Works.

South Wales ores, smelted with cold blast at the Blaenavon and Pontypool Works.

No. 3. North Midland ores, used at the West Hallam Works.

No. 4. Northamptonshire ores, used at the East End and Heyford Works.

North Staffordshire ore, used at the Goldendale Works.

North Midland ores, used at the Butterley Works.

No. 5. Cleveland ores, used at the South Bank and Stockton Works.

It will scarcely be out of place to conclude these few remarks on the results of the analytical examinations, with some notice of the very considerable difference observed in the structure of many of the samples of iron analysed, and particularly in the physical condition of the so-called graphite, as exhibited by fresh fractures of the metal. In some instances a grey iron containing a per-centage of graphite similar to, or even higher than, that in a second sample, exhibited a dense compact structure, while that of the other sample was open-grained, and showed the existence of the graphite in large and distinct scales. These modifications in the structure of pig-iron are so well known, that they are only alluded to because it is to them that must undoubtedly be ascribed, in many instances, the apparent discrepancies (which may be noticed by a comparison of the results included in this Report) between the chemical quality of a sample of iron and the results which it has furnished when submitted to mechanical tests. It is self-evident that a sample of grey iron, compact and uniform in structure, may resist the application, for example, of a much more considerable tensile strain, than one which is of higher chemical quality (*e. g.* containing less silicon or phosphorus), but of which the structure is comparatively open and irregular. There is little doubt, also, from the results of numerous experiments which have been made in this direction, that the effect of adding considerably to the strength of some kinds of cast-iron, by repeatedly re-melting them, is, within certain limits, due to no important chemical change effected in the iron, but to the gradual production of a more thoroughly uniform mass, in which the graphitic carbon has gradually undergone a material change in its state of aggregation.

F. A. Abel,
Chemist of the War Department.

I.—Tabulated Statement, embracing the Important Per-centage Results obtained in the Examination of the Samples of Pig Iron.

SOURCE OF SUPPLY.	District.	DESCRIPTION OF IRON.	Combined Carbon.	Graphite.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Constituents Additional.
Hæmatite Foundry, Whitehaven	Northern	No. 1, Foundry Pig	none	3·22	3·02	none	0·06	0·11	Arsenic, trace. Copper, minute trace.
		No. 2, Foundry Pig	-	2·24	2·77	0·01	0·05	0·07	
		No. 3, Foundry Pig	-	2·30	2·72	0·05	0·05	trace	
		No. 4, Foundry Pig	0·35	1·86	2·63	0·10	0·03	0·07	
Weardale Iron Company	ditto	No. 1, Pig Iron	-	3·24	1·80	0·04	0·19	1·45	Lead, minute trace.
		No. 3, Pig Iron	-	2·26	4·25	0·06	0·07	1·04	
		No. 4, Pig Iron	-	2·15	1·18	0·12	0·19	trace.	
		Remelted Pig Iron	-	2·21	1·88	0·10	0·19	0·13	
South Bank Furnaces, Middlesbro'-on-Tees.	North Midland	No. 2, Foundry Pig, toughened iron.	-	3·44	1·13	0·03	1·24	0·43	
		No. 2, Foundry Pig, ordinary	-	3·04	2·73	0·04	1·30	0·38	
Stockton Iron Works	ditto	No. 1, Pig Iron	-	3·35	1·57	0·04	1·38	0·07	
		No. 3, Pig Iron	-	3·31	1·43	0·03	1·36	0·06	
Butterley Iron Works, Derbyshire.	ditto	No. 1, Pig Iron	-	3·35	1·27	0·02	1·09	1·01	
		No. 2, Pig Iron	-	2·74	2·36	0·02	1·21	1·06	
		No. 3, Pig Iron	-	2·71	1·75	0·04	1·15	0·95	
		No. 4, Pig Iron	-	2·60	1·34	0·11	0·75	0·40	
West Hallam Iron Works, Ilkeston, Derbyshire.	ditto	No. 1, Foundry Pig	-	2·31	2·23	0·02	0·72	0·88	
		No. 2, Foundry Pig	-	2·40	1·50	0·06	0·34	0·60	
		No. 3, Foundry Pig	-	2·60	1·26	0·05	0·72	0·45	
		Grey Forge Pig	-	2·74	1·41	0·03	0·95	0·89	
		No. 4, Strong Forge Pig	-	2·57	1·53	0·05	0·70	0·94	
Goldendale Iron Works, near Stoke-upon-Trent.	North Staffordshire.	Pig Iron	-	2·54	2·71	0·04	1·07	0·93	
Netherton Iron Works, near Dudley.	South Staffordshire.	No. 1, Melting Pig (cold blast)	-	3·07	1·48	0·03	0·43	0·96	
		No. 2, Melting Pig (ditto)	-	3·04	1·27	0·04	0·34	0·80	
		Grey Forge Pig (ditto)	-	3 12	1·16	0·05	0·44	0·94	
		Forge Pig (ditto)	-	3·03	0·83	0·04	0·31	0·27	
		Strong Forge Pig (ditto)	-	2·81	0·57	0·06	0·29	0·13	
Park Head Furnaces, Dudley	ditto	No. 1, Pig Iron (cold blast)	-	2·89	0·96	0·06	0·58	0·55	
		Grey Forge Pig (ditto)	-	2·90	1·63	0·03	0·55	0·95	
		Forge Pig (ditto)	-	3·00	1·21	0·10	0·48	0·86	
Old Hill Furnaces, near Dudley	ditto	No. 2, Pig Iron	-	3·06	3·48	0·03	0·38	0·30	
		No. 3, Pig Iron	-	2·69	2·24	0·04	0·63	0·34	
		No. 4, Pig Iron	-	2·76	1·75	0·07	0·55	trace.	
		No. 5, Pig Iron	0·25	2·55	1·36	0·11	0·41	0·54	
Lays Iron Works, near Dudley	ditto	Pig Iron, first melting	-	3·15	1·05	0·05	0·29	1·14	
Level Iron Works, Brierley Hill	ditto	Pig Iron (hot blast)	-	2·61	1·40	0·04	0·72	0·49	
		Pig Iron (cold blast)	-	2·56	1·75	0·05	0·63	0·06	
East End Iron Works, Wellingborough.	Northamptonshire	No. 1, Pig Iron (cold blast)	-	2·85	1·92	0·10	1·19	0·24	
		Mottled Iron (ditto)	not determined.	2·10	2·11	0·13	1·07	0·08	
Heyford Iron Works, near Weedon.	ditto	Pig Iron, first melting	-	2·64	4·63	0·07	1·31	trace.	
Park End Furnaces, Gloucestershire.	Forest of Dean	No. 1, Pig Iron	-	3·26	2·34	0·04	0·14	0·23	
		Grey Forge Pig	-	3·08	2·18	0·06	0·14	0·14	
Ystalyfera Iron Works, near Swansea.	South Wales	No. 1, Pig Iron (second melting)	-	3·27	1·87	0·05	0·41	0·27	
		No. 2, Pig Iron (ditto)	-	2·92	1·73	0·06	0·29	0·39	
		No. 3, Pig Iron (ditto)	-	2·61	1·71	0·05	0·38	0·27	
		No. 1, Pig Iron (first melting)	-	3 17	1·58	0·05	0·42	0·32	
		No. 2, Pig Iron (ditto)	-	2·55	2·07	0·09	0·38	0·14	
		No. 3, Pig Iron (ditto)	-	3·16	1·55	0·06	0·27	0·43	
Blaenavon Iron Works	ditto	No. 1, & C., Pig Iron (cold blast)	-	2·82	0·81	0·06	0·38	0·53	
		No. 1, Pig Iron (ditto)	-	3·40	1·36	0·07	0·29	0·28	
		Common Forge (ditto)	-	2·64	1·68	0·08	0·27	0·66	
		No. 3, Pig Iron (ditto)	-	2·88	1·09	0·08	0·38	0·66	
Pontypool Iron Works	ditto	Cold blast Pig Iron	-	2·42	1·46	0·12	0·32	0·42	

II.—Tabulated Statement, embracing the Important Per-centage Results obtained in the Examination of the Samples of Iron Ore.

SOURCE OF SUPPLY.	DISTRICT.	NATURE OF ORES.	Metallic Iron.	IRON.		Protoxide of Manganese.	Alumina.	Lime.	Magnesia.	Phosphoric Acid.	Bisulphide of Iron.	Clay, Ignited.	Silica.
				Peroxide.	Protoxide.								
Hæmatite Foundry, Whitehaven	Northern	Hæmatite	69·10	98·71	—	trace	—	trace	—	trace	—	—	1·00
Weardale Iron Company	ditto	Spathose ore, partially altered to hydrated peroxide.	43·02	49·57	10·77	3·06	0·84	5·68	1·20	0·01	0·03	—	6·64
South Bank Furnaces, Middlesbro'-on-Tees.	North Midland	Oolitic carbonate of iron with silicate.	35·46	2·86	43·02	0·40	5·87	5·14	5·21	1·81	trace	—	7·12
Stockton Iron Works	ditto	ditto	32·78	3·50	39·00	1·30	7·46	7·44	3·82	1·60	—	—	9·46
Butterley Iron Works	ditto	"Brown Rake," clay ironstone	30·60	1·04	37·99	1·51	5·57	4·59	3·37	0·81	0·06	16·35	10·04
		"Blue Rake," clay ironstone	—	—	—	—	—	—	—	1·46	—	—	—
Goldendale Iron Works	North Staffordshire	Clay ironstone, from chalky mine.	35·55	—	45·71	1·20	—	3·37	1·93	1·42	0·13	9·66	—
Netherton Iron Works, near Dudley	South Staffordshire	"Binds," clay ironstone	35·25	—	44·74	0·50	—	1·70	2·05	0·72	trace	18·17	—
		"Whitestone"	40·32	—	51·52	0·56	—	1·28	1·66	0·60	trace	10·07	—
		"Whitestone," containing fossil shells.	37·35	—	47·70	0·84	—	2·85	2·45	0·56	—	9·87	—
		"Gubbin"	38·60	—	49·28	1·24	—	1·29	0·92	0·66	—	11·09	—
		"Grains," seamed with lime-spar.	39·45	—	50·40	0·75	—	1·70	1·19	0·45	—	9·70	—
		"Grains," uniform	37·97	—	48·43	0·84	—	1·00	1·32	0·59	—	12·41	—
Park Head Furnaces, Dudley	ditto	"Bottom stone," roasted	57·10	—	—	—	—	—	—	0·78	—	13·42	—
		"Binds," roasted	54·43	—	—	—	—	—	—	0·67	—	12·18	—
		"Gubbin," roasted	59·87	—	—	—	—	—	—	0·62	—	12·50	—
		"Rubble," roasted	47·93	—	—	—	—	—	—	0·52	—	24·30	—
Old Hill Furnaces, near Dudley	ditto	"Whitestone," West Bromwich	34·00	—	43·33	0·60	—	4·53	2·66	0·78	0·16	13·21	—
		"Gubbin," Bell Farm	41·02	—	52·50	1·00	—	1·06	0·58	0·75	trace	8·70	—
		"Grains," Bell Farm	38·32	—	48·96	1·06	—	3·73	0·84	0·72	trace	9·40	—
		"Balls," Bilston	37·70	—	48·00	0·57	—	1·10	1·21	1·07	0·18	15·70	—
Lays Iron Works, near Dudley	ditto	"Bottom whitestone"	37·85	—	48·63	1·29	3·64	4·45	0·80	0·82	0·16	10·30	6·21
Level Iron Works, Brierley Hill	ditto	"Gubbin," raw	41·67	—	53·58	—	—	—	—	0·83	—	4·80	—
		"White Ironstone"	37·93	—	48·77	—	—	—	—	1·18	trace	9·30	—
East End Iron Works, Wellingborough.	Northamptonshire	Ochrey-brown ironstone	53·20	76·00	trace	0·40	2·30	0·23	0·05	1·03	—	—	5·33
Heyford Iron Works, near Weedon	ditto	ditto	39·34	56·20	trace	0·20	2·43	0·28	0·08	0·84	—	—	29·07
Park End Furnaces, Gloucestershire.	Forest of Dean	"Brush" ore	63·50	90·70	trace	trace	trace	trace		0·07	—		0·60
		"Grey vein"	29·30	41·86	trace	trace	—	17·02	10·24	0·13	—		1·32
Ystalyfera Iron Works, near Swansea.	South Wales	"Cheese" mine	33·45	—	42·72	0·46	—	4·66	5·73	0·49	trace	8·23	—
Blaenavon Iron Works	ditto	"Black Pins" ironstone	36·77	—	47·02	1·00	—	2·57	3·23	0·92	0·25	8·63	—
		"Pwll Llacca"	37·32	—	47·60	0·46	—	0·77	2·30	0·71	0·08	13·60	—
		"Bottom vein"	33·20	—	42·04	0·87	—	1·03	2·51	0·90	0·06	20·87	—
		"Ball Mine"	40·12	—	51·28	1·11	—	0·78	0·53	0·74	0·06	10·33	—
		"Grey vein"	31·45	—	39·80	1·17	—	2·41	3·30	1·02	0·05	19·40	—
Pontypool Iron Works	ditto	Calcined ore	56·83	—	—	—	—	—	—	0·73	—	9·60	—

III. TABULATED STATEMENT, embracing the Important Per-centage Results obtained in the Examination of the Samples of FLUX and of FUEL.

SOURCE OF SUPPLY.	DISTRICT.	NATURE OF FLUX.	Carbonate of Lime.	Carbonate of Magnesia.	Carbonate of Iron.	Carbonate of Manganese.	Phosphate of Lime.	Sand and Clay.	NATURE OF FUEL.	Sulphur.	Ash.
Hæmatite Foundry, Whitehaven	Northern	Limestone	97·63	1·03	0·24	0·11	trace	0·86	Newcastle coke	0·80	4·45
		Shale flux	Silicate of alumina with carbonaceous matter						Whitehaven coke	1·38	12·16
Weardale Iron Company	ditto	Limestone	95·55	3·20	trace	—	0·12	0·90	Coke	0·60	5·16
South Bank Furnaces, Middlesbro'-on-Tees.	North Midland	Limestone	83·65	13·43	1·71	trace	trace	0·64	Coke	1·05	5·03
Stockton Iron Works	ditto	Limestone, Broadwood Quarries	95·92	1·85	0·53	trace	—	1·70	Coke	0·91	7·90
Goldendale Iron Works	North Staffordshire	Froghall limestone	97·89	0·87	0·48	trace	trace	0·63	Coal, from North Wales	not analysed.	
Netherton Iron Works, near Dudley	South Staffordshire	Limestone, Dudley Quarries	97·31	1·00	0·62	—	—	1·27	"Thick coal" coke	0·31	4·18
Park Head Furnaces, Dudley	ditto	Limestone, Dudley Quarries	97·10	0·85	0·60	—	—	1·15	"Thick coal" coke	0·40	3·78
									"Heathen" coke	0·51	4·58
Old Hill Furnaces, near Dudley	ditto	Limestone, Springfield Mine	88·85	2·03	1·21	trace	0·26	8·15	"Thick coal" coke	0·51	4·83
Level Iron Works, Brierley Hill	ditto	Limestone	not determined.	0·70	Similar in character to that used at the Park Head Furnaces.				"Thick coal" coke	0·50	2·66
East End Iron Works, Wellingborough.	Northamptonshire	Argillaceous limestone (oolitic)	89·36	0·97	3·38	Ferruginous clay and sand		6·00	Barnsley coal	0·65	4·76
		Chalk	almost entirely.	trace	—	—	—	trace.			
Heyford Iron Works, near Weedon	ditto	Shell limestone	96·86	0·90	1·36	—	—	0·88	Coke, from Barnsley coal	0·52	6·58
Park End Furnaces, Gloucestershire.	Forest of Dean	Burnt shale flux	Silicate of alumina with peroxide of iron, and traces of lime and magnesia						Parkend coke	0·90	8·20
Ystalyfera Iron Works, near Swansea.	South Wales	Limestone	99·49	none	0·18	0·07	trace	0·26	Anthracite	0·70	9·14
Blaenavon Iron Works	ditto	Rough limestone	98·55	0·54	0·50	—	0·03	0·73	"Three-quarters coal" coke.	0·74	5·35
		Smooth limestone (oolitic)	99·26	0·63	0·33	—	0·02	0·27			
Pontypool Iron Works	ditto	No sample of flux was received							Pontypool coke	0·76	12·15

APPENDIX.

The whole of the Mechanical Trials enumerated in the Appendix have been conducted in the same manner, and under similar circumstances, to those which precede.

MESSRS. BEGBIE,

PIG

CASTING.

Cast - - - 17 October 1856.
Barometer - - - 30·36
Thermometer - - 65°

Weight of—	cwts.	qrs.	lbs.
Charge - -	5	0	0
Castings - -	3	3	13
Runners - -	0	1	13
Slag and waste	0	3	21
Coals consumed	3	3	7

Time of—	hrs.	min.
Melting - - -	1	15
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1900	Mark $\frac{22}{1}$.	Horizontal. Slow	1	–	–	–	–	–	–	–	–	–	–	–	–	1·96	2·01	7·9185	·050	·001	–	–	–	–	·090	8,500	5,367	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1901			2	–	–	–	–	–	–	–	–	–	–	–	–	1·97	1·97	7·6453	·054	·004	–	–	–	–	·104	9,000	5,885	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1902			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1903	CAST.	Horizontal. Gradual	1	–	–	–	–	–	–	–	–	–	–	–	–	2·00	1·94	7·5272	·049	·001	–	–	–	–	·097	8,900	5,911	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1904	17 October 1856.		2	–	–	–	–	–	–	–	–	–	–	–	–	2·01	1·94	7·5648	·052	·003	–	–	–	–	·095	8,900	5,882	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1905			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1906	TESTED.	Quick	1	–	–	–	–	–	–	–	–	–	–	–	–	2·06	1·95	7·8331	·053	·001	–	–	–	–	·083	9,200	5,872	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1907	Transverse, 31 Oct. 1857.		2	–	–	–	–	–	–	–	–	–	–	–	–	2·00	1·96	7·6832	·050	·002	–	–	–	–	·096	9,800*	6,377*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1908	Temp. 55°.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1909		Vertical. Slow	1	–	–	–	–	–	–	–	–	–	–	–	–	1·98	1·99	7·8409	·049	·003	–	–	–	–	·090	8,900	5,675	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1910	FRACTURE.		2	–	–	–	–	–	–	–	–	–	–	–	–	2·02	2·01	8·1610	·047	·003	–	–	–	–	·095	8,900	5,452	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1911	Centre Medium Grey.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1912	Margin Silvery. Regular.		1	–	–	–	–	–	–	–	–	–	–	–	–	2·03	2·03	8·3654	·050	·001	–	–	–	–	·100	8,900	5,319	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1913	Medium Grain.		2	–	–	–	–	–	–	–	–	–	–	–	–	1·98	2·00	7·9200	·051	·003	–	–	–	–	·085	8,000	5,050	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1914			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1915	This sample being too hard to turn into cylinders could only be tested by transverse strain.		1	–	–	–	–	–	–	–	–	–	–	–	–	2·00	2·01	8·0802	·052	·006	–	–	–	–	·091	8,600	5,321	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1916			2	–	–	–	–	–	–	–	–	–	–	–	–	1·99	2·00	7·9600	·054	·004	–	–	–	–	·100	9,500	5,967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1917			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			–	–	–	–	–	–	–	–	–	–	–	–	2·00	1·98	7·8408	·050	·002	–	–	–	–	·094	8,925*	5,673*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 54, at the end.

SWEDISH GREY IRON.

IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·21
Silicon	0·86
Sulphur	0·03
Phosphorus	0·10
Manganese	0·17

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	$\frac{L.}{D.}$ Ratio	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,626	- -	- -	- -	2·511	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,896	- -	- -	- -	2·632	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	6,124*	- -	- -	- -	2·733*	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,563	- -	- -	- -	2·483	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,184	- -	- -	- -	2·314	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,644	- -	- -	- -	2·519	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,673*	- -	- -	- -	2·532*	—	—
Combined Means - - -		Slow, Gradual and Quick cooling - - -		Horizontal - - -																		- -	- -	- -	- -	5,882*	- -	- -	- -	2·625*	—	—
				Vertical - - - -																		- -	- -	- -	- -	5,464	- -	- -	- -	2·439	—	—
		Horizontally and Vertically cast - - -		Slow - - - - -																		- -	- -	- -	- -	5,594	- -	- -	- -	2·497	—	—
				Gradual - - - -																		- -	- -	- -	- -	5,540	- -	- -	- -	2·473	—	—
				Quick - - - - -																		- -	- -	- -	- -	5,884*	- -	- -	- -	2·626*	—	—
																										Ratio in terms of the Crushing Force - - -				—	—	—

MESSRS. SWEETLAND, ACADIAN

NOVA SCOTIA—

CASTING.

Cast	- - - 17 October 1856.	Weight of—	*cwt.*	*qrs.*	*lbs.*	Time of—	*hrs.*	*min.*
Barometer	- - - 30·36	Charge - - -	5	0	0	Melting - - -	0	52
Thermometer	- - - 65°	Castings - - -	2	3	14	Remaining in the moulds for the three modes of cooling—		
		Runners - - -	0	1	15	Slow - - -	24	0
		Slag and waste -	0	3	9	Gradual - -	4	0
		Coals consumed -	3	1	8	Quick - - -	0	30
						Tapping after melting - -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1918	Mark $\frac{23}{1}$.	Horizontal. Slow -	1	7·205	1·3	·001	·005	·008	·011	–	–	–	·014	32,000	24,108	2·00	1·98	7·8408	·060	·005	·134	·020	–	–	·201	13,500	8,608	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1919			2	7·209	1·3	·003	·006	·010	–	–	–	–	·011	29,500	22,225	2·04	2·00	8·1600	·060	·005	·133	·020	–	–	·185	12,600	7,720	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1920	CAST.		3	7·206	1·3	·001	·004	·007	·008	–	–	–	·010	31,200	23,506	–	–	–	–	–	–	–	–	–	–	–	–	1·797	4·	1·2	2·8	12·8	7·7	5·1	–	–	–	–	–	–	26°·5
1921	17 October 1856.		1	7·229	1·3	·000	·003	·006	·008	–	–	–	·011	32,900	24,786	1·99	1·94	7·4895	·060	·005	·136	·021	–	–	·220	13,300	8,879	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1922	TESTED.		2	7 221	1·3	·002	·004	·007	·009	–	–	–	·011	30,500	22,978	2·03	1·99	8·0390	·057	·004	·125	·015	–	–	·209	13,700	8,520	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1923	Tensile, 4 Feb. 1858. Temp. 60°.		3	7·221	1·3	·001	·005	·008	·009	–	–	–	·012	32,900	24,786	–	–	–	–	–	–	–	–	–	–	–	–	1·794	3·5	1·1	2·4	11·2	6·9	4·3	–	–	–	–	–	–	22°·
1924	Transverse, 31 Oct. 1857.		1	7·204	1·3	·000	·002	·004	·008	–	–	–	·008	30,000	22,601	2·03	1·99	8·0390	·060	·005	·126	·014	–	–	·220	14,600	9,080	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1925	Temp. 55°.	Quick -	2	7·211	1·3	·002	·004	·007	–	–	–	–	·008	29,500	22,225	2·00	2·03	8·2418	·055	·003	·118	·010	–	–	·209	14,800	8,978	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1926	Torsion, 26 Nov. 1857. Temp. 52°.		3	7·198	1·3	·003	·007	·010	·012	–	–	–	·017	32,900	24,786	–	–	–	–	–	–	–	–	–	–	–	–	1·795	3·7	·5	3·2	8·9	4·1	4·8	–	–	–	–	–	–	14°·
1927			1	7·200	1·3	·002	·005	·008	–	–	–	–	·011	28,000	21,095	2·03	2·03	8·3654	·056	·005	·135	·020	–	–	·173	11,900	7,112	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1928	Crushing, 5 Feb. 1859.	Slow -	2	7·198	1·3	·002	·005	·009	–	–	–	–	·014	29,700	22,375	2·03	2·06	8·6145	·060	·004	·135	·021	–	–	·196	12,800	7,429	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1929	Temp. 54°.		3	7·220	1·3	·003	·006	·010	–	–	–	–	·013	29,900	22,526	–	–	–	–	–	–	–	–	–	–	–	–	1·796	3·6	1·1	2·5	11·8	7·	4·8	–	–	–	–	–	–	24°·9
1930	FRACTURE. Medium Grey.	Vertical.	1	7·219	1·3	·002	·005	·008	·012	–	–	–	·013	31,900	24,033	1·98	2·00	7·9200	·065	·007	·091	·020	–	–	·202	10,750	6,786	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1931	Bluish.	Gradual	2	7·188	1·3	·001	·004	·007	–	–	–	–	·009	29,000	21,848	2·03	2·04	8·4480	·059	·005	·135	·025	–	–	·205	13,200	7,812	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1932	Regular. Medium Grain.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1933	Good and soft working.		1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1934		Quick -	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1935			3	7·206	1·3	·002	·004	·006	·010	–	–	–	·012	31,900	24,033	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·8	1·1	2·7	13·2	8·2	5·	–	–	–	–	–	–	25°·
	GENERAL MEAN - -			7·209	1·3	·001	·004	·007	·009	–	–	–	·011	30,789	23,194	2·01	2·00	8·0400	·059	·004	·126	·018	–	–	·202	13,115	8,092	1·796	3·7	1·	2·7	11·6	6·8	4·8	–	–	–	–	–	–	22°·5

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 55, at the end.

CHARCOAL IRON COMPANY.

PIG IRON.

CHEMICAL ANALYSIS.

See TABLE.

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·206	23,279	8,164	7,970	84,175	10·392	3·644	3·558	37·578
1,850	7,970	37°	2·08	1·3	·6	2·16	·025	·011	·014	·055	·034	·021	–	–	–	–	–	–	–	–	–	23,800	84,175									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·223	24,183	8,699	7,577	91,955	10·795	3·883	3·382	41·051
1,750	7,577	36°	2·04	1·3	·6	2·16	·023	·009	·014	·049	·025	·024	·109	·079	·030	–	–	–	–	–	–	26,000	91,955									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·204	23,204	9,029	7,218	86,650	10·358	4·030	3·222	38·683
1,670	7,218	41°	2·09	1·3	·6	2·16	·021	·007	·014	·045	·024	·021	–	–	–	–	–	–	–	–	–	24,500	86,650									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·206	21,998	7,270	8,026	87,004	9·820	3·245	3·583	38·839
1,860	8,026	35°	1·75	1·3	·6	2·16	·025	·009	·016	·050	·029	·021	–	–	–	–	–	–	–	–	–	24,600	87,004									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·203	22,940	7,299	- -	- -	10·241	3·258	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·206	24,033	- -	7,840	84,882	10·729	- -	3·500	37·893
1,820	7,840	40°	2·12	1·3	·6	2·16	·028	·011	·017	·057	·034	·023	–	–	–	–	–	–	–	–	–	24,000	84,882									
1,790	7,726	38°	2·01	1·3	·6	2·16	·024	·009	·015	·051	·029	·022	·109	·079	·030	–	–	–	–	–	–	24,580	86,933	7·209	23,194	8,092	7,726	86,933	10·354	3·612	3·449	38·809
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																							7·211	23,555	8,630	7,588	87,593	10·515	3·852	3·387	39·104
																							7·205	22,651	7,284	7,933	85,043	10·112	3·251	3·541	38·366
Horizontally and Vertically cast - - - Slow - - - - -																							7·206	22,638	7,717	7,998	85,590	10·106	3·445	3·570	38·209
																						Gradual - - - -	7·213	23,561	7,999	7,577	91,955	10·518	3·570	3·382	41·051
																						Quick - - - -	7·205	23,618	9,029	7,529	85,766	10·543	4·030	3·361	38·288
																												Ratio in terms of the Crushing Force - - -				·266	·093	·088	1·000

MESSRS. SWEETLAND, ACADIAN

NOVA SCOTIA WHITE

CASTING.

Cast - - - 17 October 1856.
Barometer - - - 30·36
Thermometer - - - 65°

Weight of—	cwt.	qrs.	lbs.
Charge - -	4	3	10
Castings - -	4	0	0
Runners - -	0	1	24
Slag and waste	0	3	25
Coals consumed	3	2	12

Time of—	hrs.	min.
Melting - - -	0	41
Remaining in the moulds for the three modes of cooling—		
Slow - - -	24	0
Gradual - -	4	0
Quick - - -	0	30
Tapping after melting -	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1936			1	–	–	–	–	–	–	–	–	–	–	–	–	1·97	1·96	7·5679	·047	·006	–	–	–	–	·073	7,000	4,624	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1937	Mark $\frac{23}{2}$.	Slow	2	–	–	–	–	–	–	–	–	–	–	–	–	2·06	1·96	7·9487	·049	·003	–	–	–	–	·059	5,500	3,474	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1938			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1939	CAST.		1	–	–	–	–	–	–	–	–	–	–	–	–	2·04	1·98	7·9976	·044	·001	–	–	–	–	·075	7,400	4,626	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1940	17 October 1856.	Horizontal. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–	1·97	1·94	7·4142	·050	·003	–	–	–	–	·060	6,100	4,113	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1941			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1942	TESTED.		1	–	–	–	–	–	–	–	–	–	–	–	–	2·00	1·96	7·6832	·050	·003	–	–	–	–	·075	7,800	5,076	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1943	Transverse, 31 Oct. 1857.	Quick	2	–	–	–	–	–	–	–	–	–	–	–	–	2·00	1·92	7·3728	·056	·003	–	–	–	–	·076	7,400	5,018	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1944	Temp. 55°.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1945			1	–	–	–	–	–	–	–	–	–	–	–	–	1·97	2·00	7·8800	·056	·010	–	–	–	–	·064	5,500	3,489	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1946		Slow	2	–	–	–	–	–	–	–	–	–	–	–	–	1·98	1·99	7·8409	·055	·011	–	–	–	–	·062	5,500	3,507	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1947	FRACTURE.		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Silvery.																																								
1948	Regular.		1	–	–	–	–	–	–	–	–	–	–	–	–	1·97	1·97	7·6453	·046	·003	–	–	–	–	·061	6,400*	4,185*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1949	Close Grain.	Vertical. Gradual	2	–	–	–	–	–	–	–	–	–	–	–	–	1·98	2·01	7·9993	·052	·010	–	–	–	–	·069	6,500	4,062	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1950			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1951	This Sample being too hard to turn into Cylinders, could only be tested by Transverse Strain.		1	–	–	–	–	–	–	–	–	–	–	–	–	1·94	1·93	7·2263	·049	·002	–	–	–	–	·064	6,200	4,289	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1952		Quick	2	–	–	–	–	–	–	–	–	–	–	–	–	1·97	1·98	7·7231	·040	·006	–	–	–	–	·053	5,000	3,237	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1953			3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	General Mean			–	–	–	–	–	–	–	–	–	–	–	–	1·98	1·97	7·6831	·049	·005	–	–	–	–	·066	6,358*	4,141*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 56, at the end.

CHARCOAL IRON COMPANY.

PIG IRON.

CHEMICAL ANALYSIS.

See TABLE.

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of												Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,049	- -	- -	- -	1·807	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,369	- -	- -	- -	1·950	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,047	- -	- -	- -	2·253	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	3,498	- -	- -	- -	1·561	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,123*	- -	- -	- -	1·840*	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	3,763	- -	- -	- -	1·679	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,141*	- -	- -	- -	1·848*	—	—

Combined Means - - -	Slow, Gradual and Quick cooling - - -	Horizontal - - -	- -	- -	- -	4,488	- -	- -	- -	2·003	—	—
		Vertical - - - -	- -	- -	- -	3,795*	- -	- -	- -	1·694*	—	—
	Horizontally and Vertically cast - - -	Slow - - - - -	- -	- -	- -	3,773	- -	- -	- -	1·684	—	—
		Gradual - - - -	- -	- -	- -	4,246*	- -	- -	- -	1·895*	—	—
		Quick - - - -	- -	- -	- -	4,405	- -	- -	- -	1·966	—	—
										Ratio in terms of the Crushing Force - - -																		

MESSRS. TOWNSEND,

No. 1.—"STERLING"

MANUFACTURE.

No. 1 "Sterling" Pig Iron, manufactured from pure black magnetic oxide of iron, and smelted with wood charcoal alone.

Taken from 10 tons in store.

CASTING.

Cast	16 October 1856.
Barometer	30·04
Thermometer	64°

Weight of—	cwt.	qrs.	lbs.
Charge	5	0	0
Castings	3	3	10
Runners	0	1	22
Slag and waste	1	1	1
Coals consumed	3	3	21

Time of—	hrs.	min.
Melting	1	7
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1882	Mark $\frac{21}{1}$.	Horizontal. Slow	1	7·197	1·3	·002	·004	·007	·008	–	–	–	·010	31,500	23,732	2·01	1·98	7·8800	·060	·004	·134	·019	–	–	·232	13,700	8,692	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1883			2	7·191	1·3	·002	·006	·010	·014	–	–	–	·015	31,000	23,355	2·02	1·98	7·9192	·058	·005	·136	·023	–	–	·261	14,800	9,344	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1884	CAST.		3	7·201	1·3	·001	·005	·008	·010	–	–	–	·011	31,900	24,033	–	–	–	–	–	–	–	–	–	–	–	–	1·796	2·9	·5	2·4	–	–	–	–	–	–	–	–	–	10°·7
1885	16 October 1856.		1	7·204	1·3	·001	·004	·007	·008	–	–	–	·010	31,800	23,958	2·03	1·97	7·8782	·059	·006	·135	·020	–	–	·255	14,600	9,266	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1886	TESTED.		2	7·220	1·299	·001	·005	·008	·010	–	–	–	·012	31,500	23,768	2·03	1·92	7·4833	·059	·003	·140	·020	–	–	·241	13,700	9,153	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1887	Tensile, 4 Feb. 1858.		3	7·204	1·3	·002	·006	·010	·011	–	–	–	·014	31,900	24,033	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·4	·6	2·8	–	–	–	–	–	–	–	–	–	7°·6
1888	Temp. 60°.		1	7·189	1·3	·000	·004	·006	·008	–	–	–	·011	33,400	25,163	2·03	2·01	8·2014	·060	·005	·134	·021	–	–	·226	13,800	8,413	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1889	Transverse, 30 Oct. 1857.	Quick	2	7·195	1·3	·003	·006	·009	·010	–	–	–	·013	32,100	24,183	2·00	2·03	8·2418	·057	·006	·125	·028	–	–	·232	14,800	8,978	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1890	Temp. 57°.		3	7·180	1·3	·000	·002	·005	·008	–	–	–	·011	33,900	25,540	–	–	–	–	–	–	–	–	–	–	–	–	1·797	3·	·7	2·3	–	–	–	–	–	–	–	–	–	10°·4
1891	Torsion, 26 Nov. 1857.		1	7·187	1·3	·002	·006	·009	–	–	–	–	·010	29,600	22,300	2·00	2·02	8·1608	·060	·003	·139	·020	–	–	·186	12,000	7,352	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1892	Temp. 52°.		2	7·195	1 3	·002	·005	·008	–	–	–	–	·010	29,400	22,149	1·97	1·99	7·8013	·060	·004	·139	·021	–	–	·245	13,800	8,844	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1893	Crushing, 3 Feb. 1859.	Slow	3	7·162	1·299	·001	·004	·007	–	–	–	–	·009	29,900	22,561	–	–	–	–	–	–	–	–	–	–	–	–	1·795	2·9	·3	2·6	–	–	–	–	–	–	–	–	–	12°·
1894	Temp. 55°.		1	7·170	1·3	·002	·006	·008	·014	–	–	–	·015	31,900	24,033	2·01	2·00	8·0400	·062	·004	·150	·021	–	–	·150	10,000	6,218	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1895	FRACTURE.		2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1896	Medium Grey.	Vertical. Gradual	3	7·102	1·3	·000	·003	·006	·008	–	–	–	·010	32,900	24,786	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·5	·4	2·1	12·2	7·4	4·8	–	–	–	–	–	–	13°·3
1897	Bright.		1	7·094	1·3	·001	·004	·008	·010	–	–	–	·012	31,700	23,882	2·02	2·00	8·0800	·055	·009	·081	·012	–	–	·150	10,500	6,497	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1898	Regular.		2	7·191	1·299	·002	·005	·009	–	–	–	–	·012	29,000	21,882	2·01	2·02	8·2016	·059	·005	·132	·015	–	–	·164	12,400	7,559	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1899	Medium Grain.		3	7·205	1·3	·002	·005	·008	–	–	–	–	010	29,300	22,074	–	–	–	–	–	–	–	–	–	–	–	–	1·797	2·2	·1	2.1	–	–	–	–	–	–	–	–	–	4 ·6
	Good and soft working.																																									
	GENERAL MEAN			7·181	1·3	·001	·004	·007	·010	–	–	–	·011	31,335	23,613	2·01	1·99	7·9598	·059	·005	·131	·020	–	–	·213	13,100	8,210	1·797	2·8	·4	2·4	–	–	–	–	–	–	–	–	–	9°·8

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 57, at the end.

NEW YORK.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·87
Silicon	1·33
Sulphur	0·02
Phosphorus	0·09
Manganese	0·08

TEST.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·196	23,706	9,018	5,825*	88,772	10·582	4·025	2·600*	39·629
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,350*	5,825*	37°	1·50	1·3	·6	2·16	·030	·018	·012	·061	·038	·023	·140	·110	·030	-	-	-	-	-	-	25,100	88,772									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·209	23,019	9,209	5,169*	89,126	10·678	4·111	2·307*	39·788
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,200*	5,169*	30°	1·55	1·3	·6	2·16	·027	·013	·014	·055	·033	·022	·118	·086	·032	-	-	-	-	-	-	25,200	89,126									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·188	24,962	8,695	5,859	81,345	11·143	3·881	2·615	36·314
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,360	5,859	35°	1·64	1·3	·6	2·16	·040	·025	·015	·058	·035	·023	-	-	-	-	-	-	-	-	-	23,000	81,345									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·181	22,336	8,098	6,094	91,248	9·971	3·615	2·720	40·735
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,410	6,094	35°	1·64	1·3	·6	2·16	·026	·012	·014	055	·030	·025	·107	·076	·031	-	-	-	-	-	-	25,800	91,248									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·136	24,409	6,218	6,505	92,309	10·892	2·775	2·904	41·209
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,510	6,505	37°	1·88	1·3	·6	2·16	·025	·012	·013	·055	·034	·021	·117	·089	·028	-	-	-	-	-	-	26,100	92,309									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·163	22,612	7,028	4,954	63,661	10·094	3·137	2·211	28·420
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,150	4,954	35°	1·69	1·3	·6	2·16	·035	·020	·015	-	-	-	-	-	-	-	-	-	-	-	-	18,000	63,661									
1,330*	5,734*	35°	1·65	1·3	·6	2·16	·031	·017	·014	·057	·034	·023	·120	·090	·030	-	-	-	-	-	-	23,867	84,410	7·181	23,613	8,210	5,734*	84,410	10·541	3·665	2·559*	37·683
Combined Means - - - Slow, Gradual, and Quick cooling - - Horizontal - - -																								7·198	24,196	8,974	5,617*	86,414	10·801	4·006	2·507*	38·577
																							Vertical - - - -	7·163	22,958	7,294	5,851	82,406	10·249	3·256	2·612	36·788
Horizontally and Vertically cast - - - Slow - - - - -																								7·189	23,021	8,558	5,959*	90,010	10·277	3·820	2·660*	40·183
																							Gradual - - - -	7·178	24,164	7,713	5,837*	90,718	10·787	3·443	2·605*	40·499
																							Quick - - - -	7·176	23,787	7,861	5,406	72,503	10·619	3·509	2·413	32·367
																													Ratio in terms of the Crushing Force - - -				·379	·097	·067	1·000

MESSRS. COOPER,

CHARCOAL

MANUFACTURE.

Charcoal Pig Iron, smelted by cold blast, run direct from the furnace.

CASTING.

Cast	16 October 1856.
Barometer	30·04
Thermometer	64·

Weight of—	cwts.	grs.	lbs.
Charge	5	0	0
Castings	4	0	3
Runners	0	1	13
Slag and waste	0	2	21
Coals consumed	4	2	1

Time of—	hrs.	min.
Melting	1	5
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1864	Mark $\frac{20}{1}$.	Horizontal. Slow	1	–	–	–	–	–	–	–	–	–	–	–	–
1865			2	–	–	–	–	–	–	–	–	–	–	–	–
1866			3	–	–	–	–	–	–	–	–	–	–	–	–
1867	CAST.	Horizontal. Gradual	1	–	–	–	–	–	–	–	–	–	–	–	–
1868	16 October 1856.		2	–	–	–	–	–	–	–	–	–	–	–	–
1869			3	–	–	–	–	–	–	–	–	–	–	–	–
1870	TESTED.	Horizontal. Quick	1	–	–	–	–	–	–	–	–	–	–	–	–
1871	Transverse, 30 Oct. 1857.		2	–	–	–	–	–	–	–	–	–	–	–	–
1872	Temp. 57°.		3	–	–	–	–	–	–	–	–	–	–	–	–
1873	FRACTURE.	Vertical. Slow	1	–	–	–	–	–	–	–	–	–	–	–	–
1874	Centre Medium Grey.		2	–	–	–	–	–	–	–	–	–	–	–	–
1875	Margin Silvery.		3	–	–	–	–	–	–	–	–	–	–	–	–
1876	Medium Grain.	Vertical. Gradual	1	–	–	–	–	–	–	–	–	–	–	–	–
1877	Regular.		2	–	–	–	–	–	–	–	–	–	–	–	–
1878			3	–	–	–	–	–	–	–	–	–	–	–	–
1879	This sample being too hard to turn into cylinders could only be tested by transverse strain.	Vertical. Quick	1	–	–	–	–	–	–	–	–	–	–	–	–
1880			2	–	–	–	–	–	–	–	–	–	–	–	–
1881			3	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN			–	–	–	–	–	–	–	–	–	–	–	–

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1864	2·04	1·98	7·9976	·056	·005	–	–	–	–	·090	5,500	3,455
1865	2·04	2·04	8·4896	·054	·004	–	–	–	–	·070	6,400	3,787
1866	–	–	–	–	–	–	–	–	–	–	–	–
1867	2·03	1·99	8·0390	·055	·001	–	–	–	–	·083	6,800	4,229
1868	2·00	1·99	7·9202	·056	·001	–	–	–	–	·077	6,900*	4,355*
1869	–	–	–	–	–	–	–	–	–	–	–	–
1870	1·98	1·98	7·7623	·056	·001	–	–	–	–	·080	6,900	4,444
1871	1·97	1·99	7·8013	·054	·003	–	–	–	–	·079	7,200	4,614
1872	–	–	–	–	–	–	–	–	–	–	–	–
1873	2·00	1·99	7·9202	·062	·004	–	–	–	–	·083	6,300	3,977
1874	1·99	1·99	7·8805	·064	·003	–	–	–	–	·065	5,700	3,614
1875	–	–	–	–	–	–	–	–	–	–	–	–
1876	2·03	2·01	8·2014	·054	·004	–	–	–	–	·076	6,600*	4,023*
1877	2·05	1·98	8·0368	·055	·005	–	–	–	–	·080	6,300	3,919
1878	–	–	–	–	–	–	–	–	–	–	–	–
1879	2·04	2·02	8·3240	·065	·010	–	–	–	–	·150	8,500	5,105
1880	1·97	1·97	7·6453	·053	·005	–	–	–	–	·103	6,000	3,923
1881	–	–	–	–	–	–	–	–	–	–	–	–
	2·01	1·99	7·9598	·057	·004	–	–	–	–	·086	6,591*	4,120*

TORSION.

Register No.	Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1864	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1865	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1866	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1867	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1868	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1869	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1870	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1871	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1872	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1873	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1874	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1875	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1876	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1877	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1878	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1879	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1880	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1881	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–	–	–

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 58, at the end.

INDIAN IRON COMPANY.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	3·38
Silicon	0·44
Sulphur	0·04
Phosphorus	0·27
Manganese	0·14

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	$\frac{L.}{D.}$ Ratio	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.

ELBA AND

MECHANICAL

ELBA

Register No.	DESCRIPTION.	Mark.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
3185	Elba Iron†	166	1	–	–	–	–	–	–	–	–	–	–	–	–	1·98	1·98	–	–	–	–	–	–	–	–	6,500	4,186	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3186		„	2	–	–	–	–	–	–	–	–	–	–	–	–	2·00	2·00	–	–	–	–	–	–	–	–	6,900	4,312	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Mean	–	–	–	–	–	–	–	–	–	–	–	–	–	1·99	1·99	–	–	–	–	–	–	–	–	6,700	4,249	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TUSCAN

Register No.	DESCRIPTION.	Mark.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
2846	Tuscan Iron†	121	1	–	–	–	–	–	–	–	–	–	–	–	–	2·02	2·01	–	–	–	–	–	–	–	–	6,500	3,982	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2847		„	2	–	–	–	–	–	–	–	–	–	–	–	–	2·03	2·03	–	–	–	–	–	–	–	–	6,500	3,885	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Mean	–	–	–	–	–	–	–	–	–	–	–	–	–	2·02	2·02	–	–	–	–	–	–	–	–	6,500	3,934	–	–	–	–	–	–	–	–	–	–	–	–	–	–

† Too hard to turn into Cylinders.

All specimens marked thus (*) are imperfect.

TUSCAN IRON.

TEST.

IRON.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	4,249	- -	- -	- -	1·896	—	—
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	—	—	—	—	—	—	—	—	—	—

IRON.

TORSION.				CRUSHING.																	MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	3,934	- -	- -	- -	1·756	—	—
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	—	—	—	—	—	—	—	—	—	—

BUTTERLEY IRON COMPANY.—

RE-MELTED

MANUFACTURE.

Manufactured and smelted in the blast furnace, with the following ingredients to every charge of ore likely to produce 480 lbs. of metal :—

	Lbs.
Oxide of manganese	42
Plumbago	8
Charcoal	14
Saltpetre	2

The above mixture may be used either with the ironstone or fuel (it being immaterial which) so long as the proportions are regularly applied with each charge.

CASTING.

Cast — 27 September 1856.
Barometer — 29·15
Thermometer — 64·

Weight of—	*cwt.*	*qrs.*	*lbs.*
Charge	5	0	0
Castings	3	2	13
Runners	0	2	17½
Slag and waste	0	3	3
Coals consumed	3	2	2

Time of—	*hrs.*	*min.*
Melting	0	53
Remaining in the moulds for the three modes of cooling—		
Slow	24	0
Gradual	4	0
Quick	0	30
Tapping after melting	0	15

MECHANICAL

Register No.	DESCRIPTION.	How Cast and Mode of Cooling.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.
1216			1	7·300	1·3	·002	·004	·007	·008	–	–	–	·009	30,500	22,978
1217	Mark $\frac{5}{1}$.	Slow	2	–	–	–	–	–	–	–	–	–	–	–	–
1218			3	7·257	1·3	·003	·006	·008	·009	–	–	–	·010	32,800	24,711
1219	CAST. 27 September 1856.	Horizontal.	1	7·190	1·3	·002	·005	·006	·007	–	–	–	·008	33,800	25,465
1220		Gradual	2	7·170	1·3	·002	·005	·007	·008	·010	–	–	·011	36,500	27,499
1221	TESTED. Tensile, 27 Sept. 1857.		3	7·177	1·3	·000	·003	·005	·006	·010	–	–	·012	36,500	27,499
1222	Temp. 66°.		1	7·215	1·3	·002	·004	·005	·007	·009	–	–	·012	39,900	30,060
1223	Transverse, 8 April 1857.	Quick	2	7·197	1·3	·000	·001	·005	·006	·007	–	–	·010	39,900	30,060
1224	Temp. 61°.		3	7·214	1·3	·003	·005	·007	·008	–	–	–	·009	34,000	25,615
1225	Torsion, 4 May 1857.		1	7·178	1·3	·000	·002	·003	·005	·007	–	–	·010	35,100	26,443
1226	Temp. 56°.	Slow	2	–	–	–	–	–	–	–	–	–	–	–	–
1227	Crushing, 3 Feb. 1859.		3	7·099	1·3	·001	004	·006	·008	–	–	–	·009	31,900	24,033
1228	Temp. 55°.		1	6·990	1·3	·000	·003	·004	·005	–	–	–	·009	34,900	26,293
1229	FRACTURE. Light Grey.	Vertical. Gradual	2	7·126	1·3	·001	·004	·005	·007	–	–	–	·008	34,000	25,615
1230	Dull.		3	7·217	1·3	·003	·004	·006	·007	–	–	–	·008	32,500	24,485
1231	Regular. Fine Grain.		1	7·238	1·282	·001	·006	–	–	–	–	–	·008	22,500*	17,430*
1232	Tolerable working qualities.	Quick	2	–	–	–	–	–	–	–	–	–	–	–	–
1233			3	7·231	1·3	·001	·003	·004	–	–	–	–	·004	26,000	19,588
	GENERAL MEAN			7·186	1·299	·002	·004	·006	·007	·009	–	–	·009	33,386*	25,185*

Register No.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.
1216	2·03	2·04	8·4480	·045	·002	·092	·006	–	–	·140	14,200	8,404
1217	–	–	–	–	–	–	–	–	–	–	–	–
1218	–	–	–	–	–	–	–	–	–	–	–	–
1219	2·01	1·99	7·9598	·045	·008	·098	·010	–	–	·144	13,700	8,605
1220	2·00	2·02	8·1608	·043	·001	·095	·005	·153	·012	·165	15,600	9,557
1221	–	–	–	–	–	–	–	–	–	–	–	–
1222	2·02	2·01	8·1610	·040	·000	·090	·002	·148	·010	·174	16,900	10,354
1223	2·00	1·99	7·9202	·046	·002	·110	·010	·160	·020	·170	15,700	9,911
1224	–	–	–	–	–	–	–	–	–	–	–	–
1225	1·97	2·06	8·3598	·048	·001	–	–	–	–	·100	10,000*	5,980*
1226	–	–	–	–	–	–	–	–	–	–	–	–
1227	–	–	–	–	–	–	–	–	–	–	–	–
1228	1·98	2·00	7·9200	·046	·001	·100	·008	–	–	·110	10,900*	6,881*
1229	1·98	1·99	7·8409	·041	·000	·094	·004	–	–	·110	11,400*	7,269*
1230	–	–	–	–	–	–	–	–	–	–	–	–
1231	1·95	1·94	7·3390	·050	·000	–	–	–	–	·109	10,000*	6,812*
1232	1·94	1·96	7·4527	·051	·001	–	–	–	–	·088	8,000*	5,367*
1233	–	–	–	–	–	–	–	–	–	–	–	–
	1·99	2·00	7·9600	·045	·002	·097	·006	·153	·014	·145	12,640*	7,914*

Register No.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
1216	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1217	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1218	1·8	–	–	–	–	–	–	–	–	–	–	–	–	1°·7
1219	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1220	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1221	1·798	–	–	–	–	–	–	–	–	–	–	–	–	3°·
1222	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1223	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1224	1·797	2·	1·	1·	–	–	–	–	–	–	–	–	–	3°·5
1225	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1226	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1227	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1228	1·796	2·2	·0	2·2	–	–	–	–	–	–	–	–	–	2°·2
1229	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1230	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1231	1·799	3·1	·0	3·1	–	–	–	–	–	–	–	–	–	5°·2
1232	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1233	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1·797	–	–	–	–	–	–	–	–	–	–	–	–	7°·7
	1·798	2·4	·3	2·1	–	–	–	–	–	–	–	–	–	3°·9

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 59, at the end.

LOW'S PATENT.

PIG IRON.

CHEMICAL ANALYSIS.

IMPORTANT CONSTITUENTS IN 100 PARTS.

Carbon, as Graphite	2·08
Silicon	1·50
Sulphur	0·11
Phosphorus	0·61
Manganese	0·33

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.												
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·278	23,844	8,404	3,858*	136,519	10·644	3·751	1·722*	60·945
900*	3,858*	36°	1·51	1·3	·6	2·16	·014	·000	·014	·026	·005	·021	·040	·012	·028	·058	·023	·035	·087	·043	·044	38,600	136,519									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·179	26,821	9,081	4,344*	123,064	11·973	4·054	1·939*	54·939
1,010*	4,344*	35°	1·94	1·3	5·99	2·17	·012	·000	·012	·030	·011	·019	·052	·030	·022	·090	·046	·044	–	–	–	34,600	123,064									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·208	28,578	10,132	5,600*	132,982	12·758	4·523	2·500*	59·366
1,300*	5,600*	36°	2·32	1·3	·6	2·16	·016	·002	·014	·031	·010	·021	·049	·021	·028	·075	·040	·035	·129	·088	·041	37,600	132,982									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·138	25,238	5,980*	4,315*	102,566	11·266	2·669*	1·926*	45·788
1,000*	4,315*	34°	1·44	1·3	·6	2·16	·017	·004	·013	·035	·012	·023	·055	·028	·027	–	–	–	–	–	–	29,000	102,566									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·111	25,464	7,075*	6,140*	130,860	11·367	3·158*	2·741*	58·419
1,430*	6,140*	35°	2·02	1·3	·6	2·16	·019	·003	·016	·030	·011	·019	·057	·033	·024	·090	·049	·041	·099	·052	·047	37,000	130,860									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·234	18,509*	6,089*	6,308*	- -	8·262*	2·718*	2·816*	—
1,000*	6,308	40°	1·44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
1,105*	4,761*	36°	1·78	1·3	·6	2·16	·016	·002	·014	·030	·010	·020	·051	·025	·026	·078	·039	·039	·105	·061	·044	35,360	125,198	7·186	25,185*	7,914*	4,761*	125,198	11·243*	3·533*	2·125*	55·891
Combined Means - - - Slow, Gradual and Quick cooling - - - Horizontal - - -																								7·215	26,736	9,366	4,600*	130,855	11·935	4·181	2·053*	58·417
Vertical - - - -																								7·154	23,412*	6,462*	4,921*	116,713	10·451*	2·884*	2·196*	52·104
Horizontally and Vertically cast - - - Slow - - - - -																								7·208	24,541	7,192*	4,086*	119,543	10·955	3·210*	1·824*	53·267
Gradual - - - -																								7·145	26,142	8,078*	5,242*	126,962	11·670	3·606*	2·340*	56·679
Quick - - - -																								7·221	23,544*	8,110*	4,954*	132,982	10·510*	3·620*	2·211*	59·366
Ratio in terms of the Crushing Force - - -																													·201	·063	·038*	1·000

LOW'S PATENT RE-MELTED IRON.

(Made from the Butterley Company's Iron.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Fuel.

Butterley Hard Coal.—An average sample of the coal contained—

Sulphur - - - - - - - - 0·52 per cent.

and left, on burning,

Ash - - - - - - - - - 2·97 per cent.

the ash consisting of burnt shale, *silicate of alumina*, with a little *peroxide of iron*, and contained no appreciable amount either of lime or magnesia.

The Patent Flux,

employed in the blast furnace, consisted, as stated by the patentee, of a mixture of coke and crude manganese ore (binoxide of manganese, containing iron), black lead, and a small proportion of saltpetre (nitrate of potassa).

Iron.

Re-melted Pig.

Important Constituents in 100 *Parts.*

Carbon, as graphite - - - - - -	2·08
Silicon - - - - - - - -	1·50
Sulphur - - - - - - - -	0·11
Phosphorus - - - - - - -	0·61
Manganese - - - - - - - -	0·33

The amount of combined carbon has not been determined.

Remark.—The nature of the influence supposed to be exerted on the quality of the iron by the employment of a flux, such as described, does not readily admit of explanation. The use, conjointly, of oxidising and reducing agents (saltpetre and carbon), and the introduction of black lead (graphite) in quantity bearing so small a proportion to that *produced* in the blast furnace, seem especially to be anomalous.

MESSRS. PRICE & NICHOLSON'S PATENT IRON.

MESSRS. PRICE & NICHOLSON'S

Stated to have been Manufactured

MECHANICAL

Register No.	DESCRIPTION.	Mark.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
2703		1	1	7·319	1·3	–	–	–	–	–	–	–	–	40,700	30,662	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2704		2	2	–	1·3	–	–	–	–	–	–	–	–	41,600	31,341	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2705		1	3	7·319	1·3	–	–	–	–	–	–	–	–	37,200	28,026	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2706		2	4	–	1·3	–	–	–	–	–	–	–	–	37,100	27,950	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2707	MESSRS. PRICE & NICHOLSON'S PURIFIED IRON.	3	5	–	1·3	–	–	–	–	–	–	–	–	41,800	31,492	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2708		1 A.	1	–	–	–	–	–	–	–	–	–	–	–	–	2·02	2·01	8·1610	–	–	–	–	–	–	–	15,500	9,496	–	–	–	–	–	–	–	–	–	–	–	–	–
2709	TESTED.	2 A.	2	–	–	–	–	–	–	–	–	–	–	–	–	1·99	2·01	8·0397	–	–	–	–	–	–	–	15,700	9,763	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2710	Tensile, 22 Oct. 1858. Temp. 58°.	3 A.	3	–	–	–	–	–	–	–	–	–	–	–	–	2·02	2·00	8·0800	–	–	–	–	–	–	–	15,900	9,839	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2711	Transverse, 12 Nov. 1858.	1 B.	4	–	–	–	–	–	–	–	–	–	–	–	–	2·07	2·01	8·3630	–	–	–	–	–	–	–	13,900	8,310	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2712	Temp. 58°.	2 B.	5	–	–	–	–	–	–	–	–	–	–	–	–	2·00	2·06	8·4872	–	–	–	–	–	–	–	14,500	8,542	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2713	FRACTURE.	3 B.	6	–	–	–	–	–	–	–	–	–	–	–	–	2·02	2·03	8·3642	–	–	–	–	–	–	–	14,600	8,769	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2714	Light Grey. Dull.																																						
2715		1	1	7·245	1·3	–	–	–	–	–	–	–	–	37,500	28,252	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2716		2	2	7·239	1·3	–	–	–	–	–	–	–	–	37,600	28,327	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2717		1	3	7·225	1·3	–	–	–	–	–	–	–	–	37,300	28,101	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2718		2	4	7·226	1·3	–	–	–	–	–	–	–	–	37,600	28,327	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		3	5	7·242	1·3	–	–	–	–	–	–	–	–	36,000	27,122	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	GENERAL MEAN - - -			7·259	1·3	–	–	–	–	–	–	–	–	38,440	28,960	2·02	2·02	8·2420	–	–	–	–	–	–	–	15,017	9,120	–	–	–	–	–	–	–	–	–	–	–	–	–	–

All specimens marked thus (*) are imperfect.

For Diagrams showing the comparative qualities of Iron when cast Horizontally and Vertically, *see* Plate No. 60, at the end.

PATENT IRON.

by their Patented process.

TEST.

TORSION.				CRUSHING.																MEAN.					RATIO—TON AS UNITY.			
Breaking Weight		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of											Breaking Weight.										
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L}{D}$.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·319	31,002	- -	- -	- -	13·840	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·319	29,156	- -	- -	- -	13·016	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -			9,699	- -	- -	- -	4·329	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -			8,540						
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -				- -	- -	- -	3·812	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·242	28,290	- -	- -	- -	12·629	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·231	27,850	- -	- -	- -	12·433	—	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·259	28,960	9,120	- -	- -	12·928	4·071	—	—

Combined Means - - -	Slow, Gradual and Quick cooling - - -	Horizontal - - -	—	—	—	—	—	—	—	—	—
		Vertical - - - -	—	—	—	—	—	—	—	—	—
	Horizontally and Vertically cast - - -	Slow - - - - -	—	—	—	—	—	—	—	—	—
		Gradual - - - -	—	—	—	—	—	—	—	—	—
		Quick - - - -	—	—	—	—	—	—	—	—	—
		Ratio in terms of the Crushing Force - - -						—	—	—	—

THE ULVERSTONE

CHARCOAL

No particulars

MECHANICAL

Register No.	DESCRIPTION.	Mark.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
3095	Ulverstone Iron†	64/267	1	–	–	–	–	–	–	–	–	–	–	–	–	2·05	2·04	8·5312	–	–	–	–	–	–	–	8,800	5,157	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3096		„	2	–	–	–	–	–	–	–	–	–	–	–	–	2·03	2·04	8·4480	–	–	–	–	–	–	–	8,200	4,853	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3147	Ulverstone Re-melted Pig‡	1	1	7·329	1·3	–	–	–	–	–	–	–	–	22,200	16,725	1·58	1·58	3·9443	–	–	–	–	–	–	–	4,700	5,957	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3148		2	2	7·330	1·3	–	–	–	–	–	–	–	–	24,500	18,458	1·58	1·59	3·9943	–	–	–	–	–	–	–	4,950	6,196	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	General Mean	–	–	7·330	1·3	–	–	–	–	–	–	–	–	23,350	17,592	1·81	1·81	6·2294	–	–	–	–	–	–	–	6,662	5,540	–	–	–	–	–	–	–	–	–	–	–	–	–	–

THE BOWLING

BOWLING

Register No.	DESCRIPTION.	Mark.	No. of Bar.	Specific Gravity.	TENSILE. Diameter.	Extension under the Pressure of 15,000 lbs.	20,000 lbs.	25,000 lbs.	30,000 lbs.	35,000 lbs.	40,000 lbs.	45,000 lbs.	At time of Breaking.	Breaking Weight. Observed.	Reduced to per Square Inch.	TRANSVERSE. Dimensions. Breadth.	Depth.	B D².	Deflection (at 20 Inches between Bearings) and Set under Pressure of 5,000 lbs. Deflection.	Set.	10,000 lbs. Deflection.	Set.	15,000 lbs. Deflection.	Set.	Ultimate Deflection.	Breaking Weight. Observed.	Reduced to per Square Inch.	TORSION. Diameter.	Angle of Torsion under the different Weights applied at 25 Inches from Centre of Bar. 1,000 lbs. Deflection.	Set.	Restoration.	1,500 lbs. Deflection.	Set.	Restoration.	2,000 lbs. Deflection.	Set.	Restoration.	2,500 lbs. Deflection.	Set.	Restoration.	Greatest Angle.
2750	Bowling Iron Gun Metal	xx	1	7·235	1·3	–	–	–	–	–	–	–	–	34,900	26,293	2·00	2·00	8·0000	–	–	–	–	–	–	–	16,000	10,000	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2751		„	2	7·231	1·3	–	–	–	–	–	–	–	–	39,000	29,382	1·99	1·98	7·8015	–	–	–	–	–	–	–	15,900	10,190	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2752	Taken from Dead Head	12	1	7·228	1·3	–	–	–	–	–	–	–	–	34,500	25,992	2·00	1·96	7·6832	–	–	–	–	–	–	–	28,000	9,110	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2753		„	2	7·237	1·3	–	–	–	–	–	–	–	–	36,900	27,800	1·98	1·98	7·7623	–	–	–	–	–	–	–	30,000	9,661	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2792	First sample – No. 2	41/207	1	7·153	1·3	–	–	–	–	–	–	–	–	20,900	15,745	1·98	1·97	7·6831	–	–	–	–	–	–	–	10,000	6,506	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2793		„	2	7·155	1·3	–	–	–	–	–	–	–	–	20,500	15,444	2·00	2·00	8·0000	–	–	–	–	–	–	–	9,900	6,187	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2794	First sample – No. 3	42/208	1	7·066	1·299	–	–	–	–	–	–	–	–	24,500	18,486	1·99	2·01	8·0397	–	–	–	–	–	–	–	8,200	5,099	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2795		„	2	7·026	1·3	–	–	–	–	–	–	–	–	22,000	16,574	2·01	2·01	8·1206	–	–	–	–	–	–	–	8,000	4,925	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Second sample – No. 2	65/264	1	7·265	1·3	–	–	–	–	–	–	–	–	37,500	28,252	2·02	2·01	8·1610	–	–	–	–	–	–	–	15,800	9,680	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3098		„	2	7·260	1·3	–	–	–	–	–	–	–	–	33,700	25,389	2 04	2·06	8·6569	–	–	–	–	–	–	–	14,400	8,317	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3099	Second sample – No. 3	66/265	1	7·287	1·3	–	–	–	–	–	–	–	–	39,900	30,060	2·04	2·02	8·3240	–	–	–	–	–	–	–	16,700	10,031	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3100		„	2	7·290	1·3	–	–	–	–	–	–	–	–	38,000	28,628	2·05	2·06	8·6583	–	–	–	–	–	–	–	17,400	10,600	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	General Mean	–		7·203	1·3	–	–	–	–	–	–	–	–	31,858	24,004	2·01	2 00	8·0400	–	–	–	–	–	–	–	15,858	8,309	–	–	–	–	–	–	–	–	–	–	–	–	–	–

† Too hard to turn.

‡ Bars planed from re-melted pig, in consequence of the above being too hard to turn into cylinders.

All specimens marked thus (*) are imperfect.

IRON COMPANY.

IRON.

known.

TEST.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	- -	- -	5,005	- -	- -	- -	2·458	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·330	17,592	6,077	- -	- -	7·853	2·712	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·330	17,592	5,540	- -	- -	7·853	2·473	—	—

IRON COMPANY.

IRON.

TORSION.				CRUSHING.																		MEAN.					RATIO—TON AS UNITY.			
Breaking Weight.		Fracture.		Dimensions.			Resistance or Variations in Form under the different Pressures of														Breaking Weight.									
							15,000 lbs.			20,000 lbs.			25,000 lbs.			30,000 lbs.			35,000 lbs.											
Observed.	Reduced to per Square Inch.	Angles from Transverse Base.	Diameters long.	Length.	Diameter.	Ratio $\frac{L.}{D.}$	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Depression.	Set.	Restoration.	Observed.	Reduced to per Square Inch.	Specific Gravity.	Tensile.	Transverse.	Torsion.	Crushing.	Tensile.	Transverse.	Torsion.	Crushing.
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·233	27,838	10,095	- -	- -	12·427	4·506	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·233	26,896	9,386	- -	- -	12·007	4·190	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·154	15,600	6,347	- -	- -	6·964	2·833	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·046	17,530	5,012	- -	- -	7·825	2·237	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·263	26,821	8,999	- -	- -	11·973	4·017	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -									
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·289	29,344	10,016	- -	- -	13·100	4·471	—	—
- -	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	- -	7·203	24,004	8,309	- -	- -	10·716	3·709	—	—

TABLE showing the various QUALITIES of CAST IRON tested at the ROYAL GUN FACTORIES, WOOLWICH.

DESCRIPTION.	NATURE.	Mark.	Mean of Samples.			Chemical Analysis.						Order of Quality.			No.	MEAN RESULTS, ARRANGED ACCORDING TO THE ORDER OF STRENGTH.								
																Specific Gravity.			Tensile.			Transverse.		
			Specific Gravity.	Tensile.	Transverse.	Manganese.	Silicon.	Carbon.		Sulphur.	Phosphorus.	Specific Gravity.	Tensile.	Transverse.		Nature.	Mark.	Specific Gravity.	Nature.	Mark.	Breaking Weight.	Nature.	Mark.	Breaking Weight.
								As Graphite.	Combined.															
FOREIGN IRONS	Swedish Grey	$\frac{22}{1}$	Too hard to turn		5,673*	0·17	0·86	3·21	–	0·03	0·10	–	–	3	1	Nova Scotia	$\frac{23}{1}$	7·209	New York	$\frac{21}{1}$	23·613	New York	$\frac{21}{1}$	8,210
	Nova Scotia Grey	$\frac{23}{1}$	7·209	23,194	8,092	0·25	1·11	3·29	–	0·01	0·13	1	2	2	2	New York	$\frac{21}{1}$	7·181	Nova Scotia	$\frac{23}{1}$	23·194	Nova Scotia	$\frac{23}{1}$	8,092
	Ditto - White	$\frac{23}{2}$	Too hard to turn		4,141*	–	0·21	–	2·96	0·02	1·53	–	–	5	3	- - - -	–	–	- - - -	–	–	Swedish	$\frac{22}{1}$	5,673*
	New York Sterling	$\frac{21}{1}$	7·181	23,613	8,210	0·08	1·33	2·87	–	0·02	0·09	2	1	1	4	- - - -	–	–	- - - -	–	–	Elba	166	4,249
	Indian Charcoal	$\frac{20}{1}$	Too hard to turn		4,120*	0·14	0·44	3·38	–	0·04	0·27	–	–	6	5	- - - -	–	–	- - - -	–	–	Nova Scotia	$\frac{23}{2}$	4,141*
	Tuscan	121	- ditto -		3,934	trace	0·88	2·91	–	0·08	0·09	–	–	7	6	- - - -	–	–	- - - -	–	–	Indian	$\frac{20}{1}$	4,120*
	Elba	166	- ditto -		4,249	–	0·71	3·08	–	0·03	0·07	–	–	4	7	- - - -	–	–	- - - -	–	–	Tuscan	121	3,934
PATENT PROCESSES.	Low's	$\frac{5}{1}$	7·186	25,185*	7,914*	0·33	1·50	2·08	–	0·11	0·61	2	2	2	1	Dr. Price's	–	7·259	Dr. Price's	–	28·960	Dr. Price's	–	9,120
	Price and Nicholson	–	7·259	28,960	9,120	–	0·24	2·54	–	0·05	0·35	1	1	1	2	Mr. Low's	$\frac{5}{1}$	7·186	Mr. Low's	$\frac{5}{1}$	25·185*	Mr. Low's	$\frac{5}{1}$	7,914*
ENGLISH IRONS	Ulverstone	$\frac{64}{267}$	Too hard to turn		5,005	–	–	–	–	–	–	–	–	8	1	Ulverstone (Re-melted Pig).	–	7·259	Bowling, No. 3	$\frac{66}{265}$	29·344	Bowling	XX 196	10,095
	Ulverstone (Re-melted Pig)	–	7·330	17,592	6,077	–	0·59	2·83	–	0·03	0·10	1	5	6	2	Bowling, No. 3	$\frac{66}{265}$	7·289	- ditto	XX 196	27·838	Bowling, No. 3	$\frac{66}{265}$	10,016
	Bowling: Gun mixture	XX 196	7·233	27,838	10,095	–	–	–	–	–	–	4	2	1	3	Bowling, No. 2	$\frac{65}{264}$	7·263	- ditto	$\frac{12}{196}$	26·896	- ditto	$\frac{12}{196}$	9,386
	Bowling: Dead head	$\frac{12}{196}$	7·233	26,896	9,386	–	0·97	2·99	–	0·05	0·50	5	3	3	4	- ditto	XX 196	7·233	Bowling, No. 2	$\frac{65}{264}$	26·821	Bowling, No. 2	$\frac{65}{264}$	8,999
	Bowling: No. 2. — First sample	$\frac{41}{207}$	7·154	15,600	6,347	–	1·08	3·32	–	0·06	0·56	6	7	5	5	- ditto	$\frac{12}{196}$	7·233	Ulverstone (Re-melted Pig).	–	17·592	- ditto, No. 2	$\frac{41}{207}$	6,347
	Bowling: No. 3. — First sample	$\frac{42}{208}$	7·046	17,530	5,012	–	1·71	3·14	–	0·07	0·67	7	6	7	6	- ditto, No. 2	$\frac{41}{207}$	7·154	Bowling, No. 3	$\frac{42}{208}$	17·530	Ulverstone (Re-melted Pig).	–	6,077
	Bowling: No. 2.—Second sample	$\frac{65}{264}$	7·263	26,821	8,999	–	1·01	2·98	–	0·03	0·49	3	4	4	7	Bowling, No. 3	$\frac{42}{208}$	7·046	Bowling, No. 2	$\frac{41}{207}$	15·600	Bowling, No. 3	$\frac{42}{208}$	5,012
	Bowling: No. 3.—Second sample	$\frac{66}{265}$	7·289	29,344	10,016	–	1·03	2·84	–	0·04	0·52	2	1	2	8	- - - -	–	–	- - - -	–	–	Ulverstone	$\frac{64}{267}$	5,005

Samples marked thus (*) have one or more defective specimens in the set. *See* preceding Tables.

BEESTON MANOR IRON WORKS, NEAR LEEDS.

(Messrs. Harding & Co.)

Chemical Report on the Iron, and Materials employed in its Manufacture.

Ore.

Black Bed Ironstone, of the coal-measures, stated to be identical with the ore employed at Low Moor. Samples both in the raw state and calcined were received, but the former only were submitted to analysis.

Clay ironstone, blackish grey in colour; homogeneous; structure, minutely crystalline; surface of fracture, smooth.

Protoxide of iron	47·13
Oxide of manganese	2·20
Lime	2·58
Magnesia	1·12
Carbonic acid	32·55
Phosphoric acid	0·96
Bisulphide of iron	trace.
Organic matter	0·30
Water, hygroscopic	0·25
Water in combination	1·75
Clay, ignited	11·30
	100·14
Metallic iron	36·70

Fuel and Flux.

No samples or description were received of the fuel and flux employed at these works.

BEESTON MANOR IRON WORKS, NEAR LEEDS—*continued.*

IRONS.

All smelted by cold blast.

Important Constituents in 100 *Parts.*

	I. No. 1 Pig.	II. No. 2 Pig.	III. No. 3 Pig.	IV. No. 4 Pig.
Carbon, as graphite - -	3·15	2·90	2·83	2·76
Silicon - - - - -	2·54	2·57	2·17	1·80
Sulphur - - - - -	0·06	0·05	0·05	0·04
Phosphorus - - - -	0·52	0·64	0·55	0·55
Manganese - - - -	1·14	1·12	1·00	0·61

Additional Sample of No. 1 Pig Iron.

Carbon, as graphite - - - - - -	3·03
Silicon - - - - - - - -	2·53
Sulphur - - - - - - - -	0·07
Phosphorus - - - - - - -	0·53
Manganese - - - - - - -	0·85

REMARKS on the Appendix-Table of Chemical Analyses.

The results exhibited in this Table may be divided into the following classes:

I. Results of the examination of average samples representing supplies made from sources included in the Report.

II. Analyses of samples of British iron specially submitted for examination or trial since the completion of the series of samples included in the body of this Report.

III. Analyses of pig iron of foreign manufacture.

IV. Results of the examination of descriptions of iron, prepared by patent processes, which have been submitted for trial.

Class I.—The samples of the iron supplied by the Netherton Works are very uniform in composition, the only material difference existing in the proportion of silicon, which varies from 1·03 to 1·66 per cent. It will be remembered that cold-blast is employed in the reduction of iron at these works.

The iron from the Park Head furnaces, where cold-blast is also employed, exhibits less variation in the amount of silicon, but a somewhat greater difference in the proportion of phosphorus. In the samples of Netherton iron, the proportion of that element varies from 0·34 to 0·45; in the samples examined from the Park Head furnaces it ranges from 0·48 to 0·60 per cent.; while in samples representing supplies of cold-blast iron from the Blaenavon Works, the highest per-centage obtained was 0·33. But little variation is also exhibited in the chemical quality of supplies of iron from the Lays Works; the silicon in samples of five parcels ranged from 1·16 to 1·60, and the phosphorus from 0·23 to 0·55. The smallest proportion of the latter element was contained in a sample prepared with cold-blast.

Class II.—The Pontypool Works having passed into the hands of other proprietors since the samples forming a part of the "series" were received, the request to have some samples of iron recently produced at those works, submitted to examination, was complied with, and two samples were analysed, which furnished results differing but little from those obtained from the original sample.

Several samples of pig iron produced at the Bowling Iron Works (Yorkshire) have been analysed; the results obtained show that they may be classed, in point of chemical quality, with the iron from the Park Head furnaces (Dudley). The ores employed at the Bowling Works appear to be the coal-measure iron-stones, such as those from the White and Black Bed Mines, which contain about 0·50 per cent. of phosphoric acid.

The samples of iron prepared at the Beeston Manor Works, near Leeds, from ores of the same character as those used at the Bowling Works, contained considerably more silicon than the iron-samples from the latter source, although cold-blast is specified as being employed in their production. Samples of Black Bed iron-stone received from these works, were examined; the per-centage of phosphoric acid in the average sample was higher than that generally contained in this description of ore, judging from the analyses published in the "Government Report." The average proportion of phosphorus in the iron is, however, not above that contained in the samples from the Bowling Works.

The high chemical quality of the sample of Hæmatite iron from Ulverston is readily explained by the employment of charcoal in its reduction.

Class III.—The samples of iron of foreign manufacture, of which analyses are given in the Appendix-Table, were most of them selected as average samples of different parcels.

No special information was received with reference to their production, but an examination of the results shows that the samples from most of the sources were undoubtedly smelted by means of charcoal.

The great variation in the nature and chemical quality of the Nova Scotia iron has rendered it necessary to give numerous analyses of iron obtained from that source, which have been selected from a much larger number, as affording a fair view of the average chemical quality of this iron. The first sample of the series, which represents one of the earliest

earliest products from Nova Scotia, is of excellent chemical quality, but a very great variation appears to exist in the character of the raw materials employed, or in the mode of treatment adopted for the reduction of the iron, from the circumstance that in some instances phosphorus, in others silicon, is found to predominate.

Class IV.—Two samples of iron have been received for examination, in the preparation of which patented processes have been applied.

One of these is described as Butterley iron, prepared by Low's patent process, which appears to consist in adding to the materials used in the blast furnace a flux consisting of a mixture of coke, crude manganese ore (binoxide of manganese, containing iron), black lead, and a small quantity of nitre.

The sample of the product which has been examined was a description of mottled iron, and contained less phosphorus than the sample of ordinary pig iron from the Butterley Works.

The sample of iron prepared under the patent of Price & Nicholson, at the works of the Lilleshall Iron Company (Shropshire), was produced by melting together grey iron of good chemical quality with so-called *metal* (the product of the finery-forge), in proportions regulated by the application which the product is to receive.

The object of the process is to produce a mottled iron of definite composition, and to reduce the per-centage of silicon in the pig iron employed, by the admixture of a material from which that element has been almost entirely abstracted.

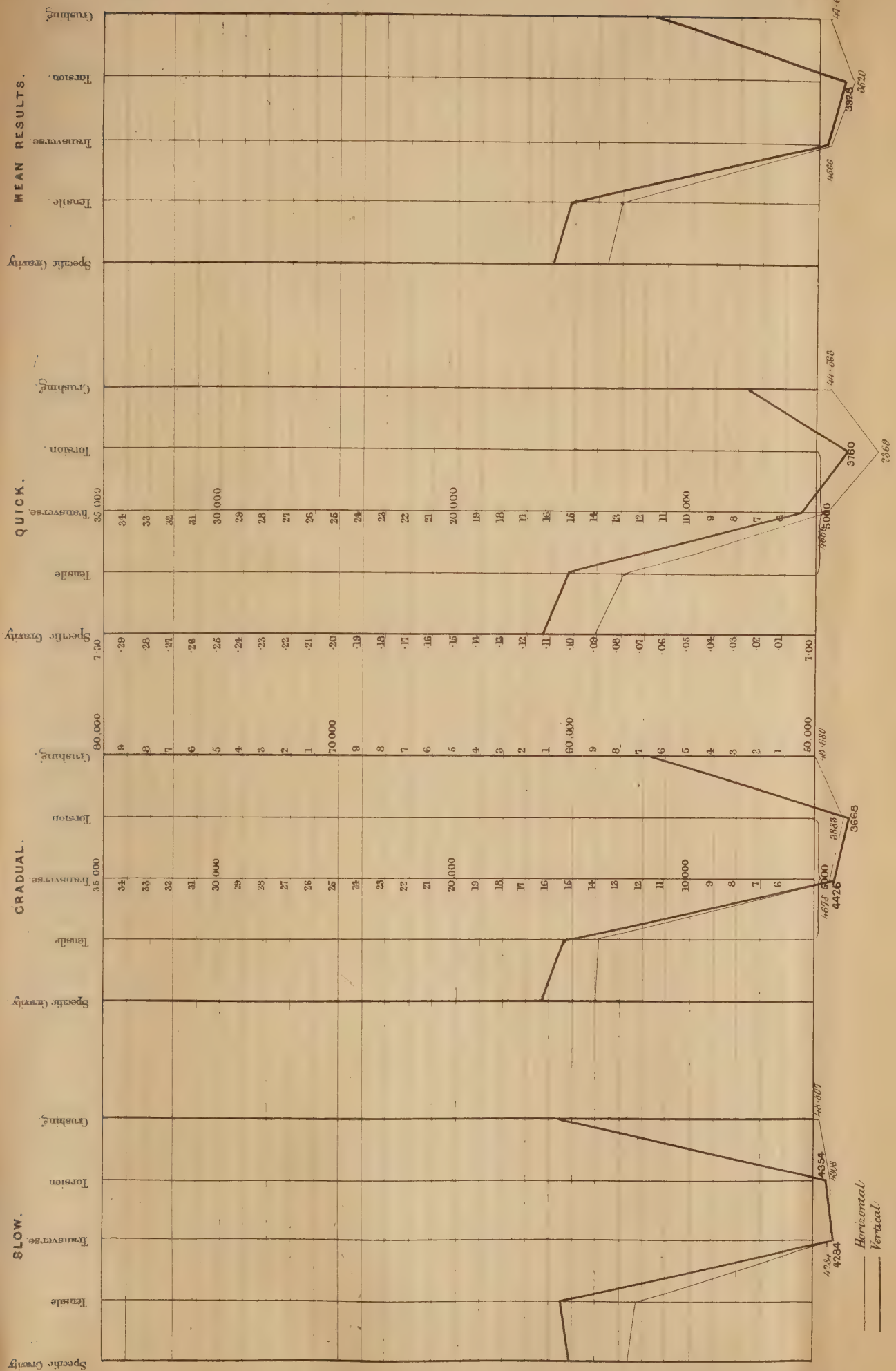
F. A. Abel.

TABLE of RESULTS obtained by the Chemical Examination of Samples of FOREIGN IRON, and of PIG IRON representing Supplies principally from the Sources included in the Report.

SOURCE OF SUPPLY.	District.	DESCRIPTION.	Graphite.	Silicon.	Sulphur.	Phosphorus.	Manganese.	
Ulverston, Mr. Ainslie	Northern	British Charcoal Iron	2·83	0·59	0·03	0·10	—	
Beeston Manor Works, near Leeds.	North Midland	Cold Blast Pig, No. 1	3·15	2·54	0·06	0·52	1·14	
		Cold Blast Pig, No. 2	2·90	2·57	0·05	0·64	1·12	
		Cold Blast Pig, No. 3	2·83	2·17	0·05	0·55	1·00	
		Cold Blast Pig, No. 4	2·76	1·80	0·04	0·55	0·61	
		Cold Blast Pig, No. 1	3·03	2·53	0·07	0·53	0·85	
Bowling Iron Works, Yorkshire.	ditto	Grey Pig Iron	2·99	0·97	0·05	0·50	—	
		Grey Pig Iron, No. 1	2·90	1·94	0·04	0·57	—	
		Grey Pig Iron, No. 2	3·32	1·08	0·06	0·56	—	
		Ditto	2·98	1·01	0·03	0·49	—	
		Grey Pig Iron, No. 3	2·80	1·51	0·06	0·44	—	
		Ditto	3·14	1·71	0·07	0·67	—	
		Ditto	2·84	1·03	0·04	0·52	—	
Netherton Iron Works, near Dudley.	South Staffordshire.	Grey Pig Iron (cold blast)	2·86	1·06	0·08	0·42	—	
		Ditto (ditto)	2·97	1·57	0·07	0·42	—	
		Ditto (ditto)	2·93	1·66	0·04	0·34	—	
		Ditto (ditto)	2·64	1·02	0·08	0·45	—	
Park Head Furnaces, Dudley.	ditto	Grey Pig Iron (cold blast)	2·83	1·19	0·08	0·55	—	
		Ditto (ditto)	2·85	0·96	0·08	0·51	—	
		Ditto (ditto)	3·33	1·18	0·05	0·48	—	
		Ditto (ditto)	3·31	1·22	0·05	0·49	—	
		Ditto (ditto)	3·11	1·33	0·07	0·58	—	
		Ditto (ditto)	2·81	1·13	0·05	0·60	—	
Lays Iron Works, near Dudley.	ditto	Grey Pig Iron	2·72	1·25	0·08	0·36	—	
		Ditto	2·87	1·16	0·08	—	—	
		Ditto	3·05	1·60	0·09	0·30	—	
		Ditto	2·85	1·33	0·09	0·41	—	
		Grey Pig Iron (warm blast)	3·34	1·18	0·07	0·55	—	
		Grey Pig Iron (cold blast)	3·21	1·54	0·07	0·23	—	
Blaenavon Iron Works	South Wales	Grey Pig Iron (cold blast)	—	1·50	0·06	0·32	—	
		Ditto (ditto)	3·06	1·25	0·07	0·28	—	
		Ditto (ditto)	3·19	1·71	0·04	0·33	—	
Pontypool Iron Works	ditto	Grey Pig Iron (cold blast)	2·53	1·23	0·08	0·46	0·42	
		Ditto (ditto)	2·68	1·35	0·09	0·50	0·45	
IRONS TREATED BY PATENT PROCESSES:								
Butterley Iron Company, Derbyshire		Low's Patent Re-melted Iron	2·08	1·50	0·11	0·61	0·33	Combined carbon, not determined.
Messrs. Price & Nicholson's Patent Process		Re-melted Pig Iron	2·54	0·24	0·05	0·35	0·24	Combined carbon, 0·12.
FOREIGN IRONS:								
Swedish Iron (Mr. Begbie)		Grey Pig Iron	3·21	0·86	0·03	0·10	0·17	
		Mottled Pig Iron	1·68	0·58	0·07	0·09	0·10	Combined carbon, not determined.
		White Pig Iron	0·94*	0·23	0·03	0·09	0·12	Combined carbon, not determined.
		Grey Pig Iron	2·93	1·27	0·04	0·07	—	
		Ditto	2·79	1·27	0·03	0·10	—	
New York (Mr. Townsend)		Grey Pig Iron	2·87	1·33	0·02	0·09	0·08	
American Iron (Mr. Buchanan)		Grey Pig Iron	3·78	0·57	none	0·20	—	
		White Pig Iron	—	small, not determined.	none	0·10	—	Combined carbon, not determined.
Nova Scotia Iron (Acadian Iron Company)		Grey Pig Iron	3·29	1·11	0·01	0·13	0·25	Combined carbon, none.
		Mottled Pig Iron	1·36	0·26	0·03	1·30	trace	Combined carbon, 1·72.
		White Pig Iron	none	0·21	0·02	1·53	none	Combined carbon, 2·96.
		Grey Mottled Pig Iron	2·62	0·74	0·02	2·10	0·26	
		Grey Pig Iron	3·49	2·77	0·01	0·13	—	
		Ditto	3·00	4·23	0·01	0·08	—	
		Ditto	3·47	3·84	0·01	0·11	—	
		Grey Mottled Pig Iron	3·00	2·25	0·01	1·67	—	
India Iron Company (Mr. Cooper)		Grey Pig Iron	3·38	0·44	0·04	0·27	0·14	
Tuscan Iron		Grey Pig Iron	2·91	0·88	0·08	0·09	trace	
Iron made from Elba Ore		Grey Pig Iron	3·08	0·71	0·03	0·07	—	
		White Pig Iron	—	—	0·04	0·06	—	Combined carbon, not determined.

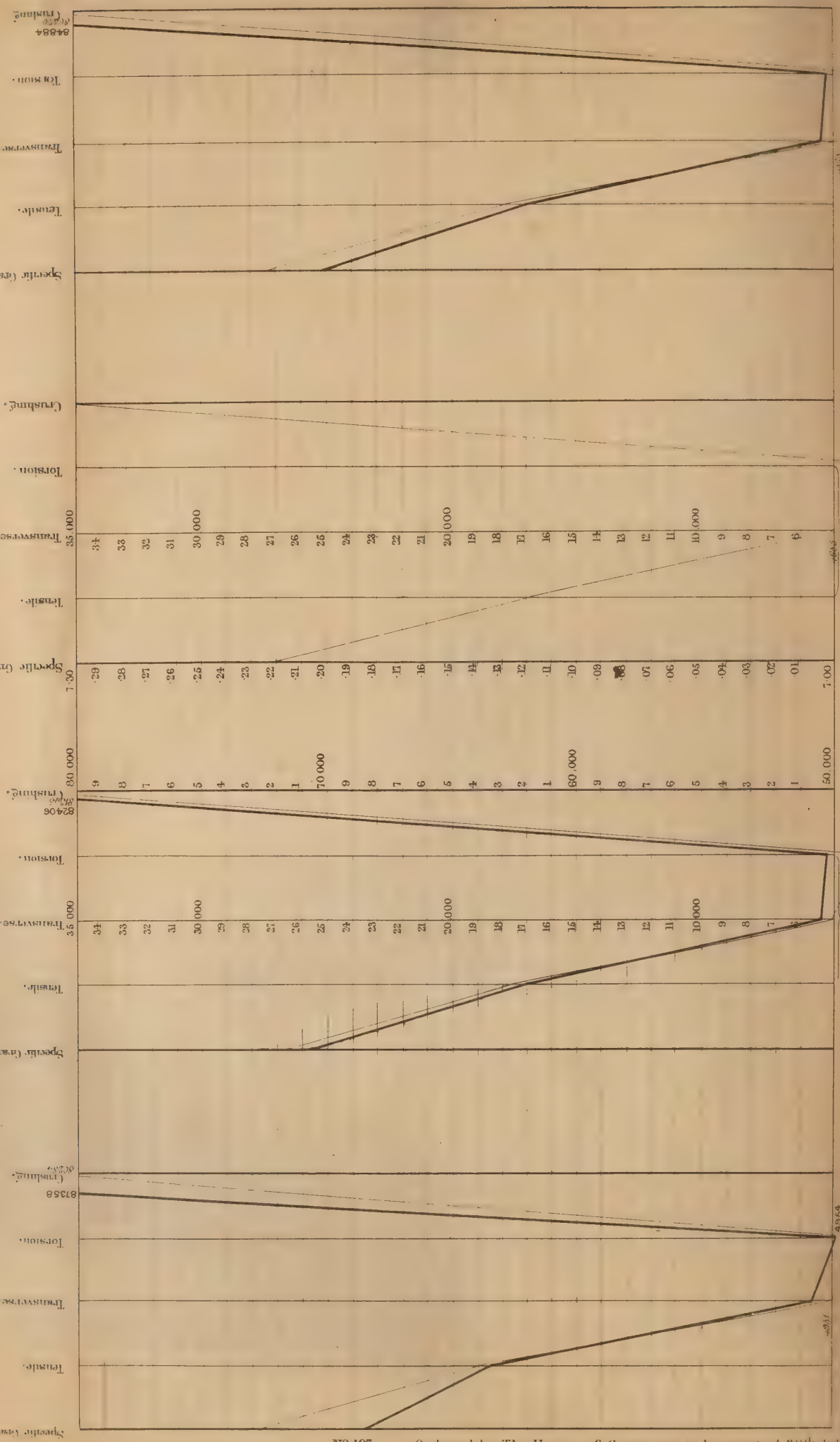
* The existence of Graphite in this sample is due to the circumstance of the white iron containing a small quantity of grey in admixture, which appeared on the surface of fracture in the form of small dark-coloured concretions.

No. 11. HÆMATITE IRON COMPANY. PLATE No 1.



No. 497. Ordered by The House of Commons to be printed, 30th July 1858.

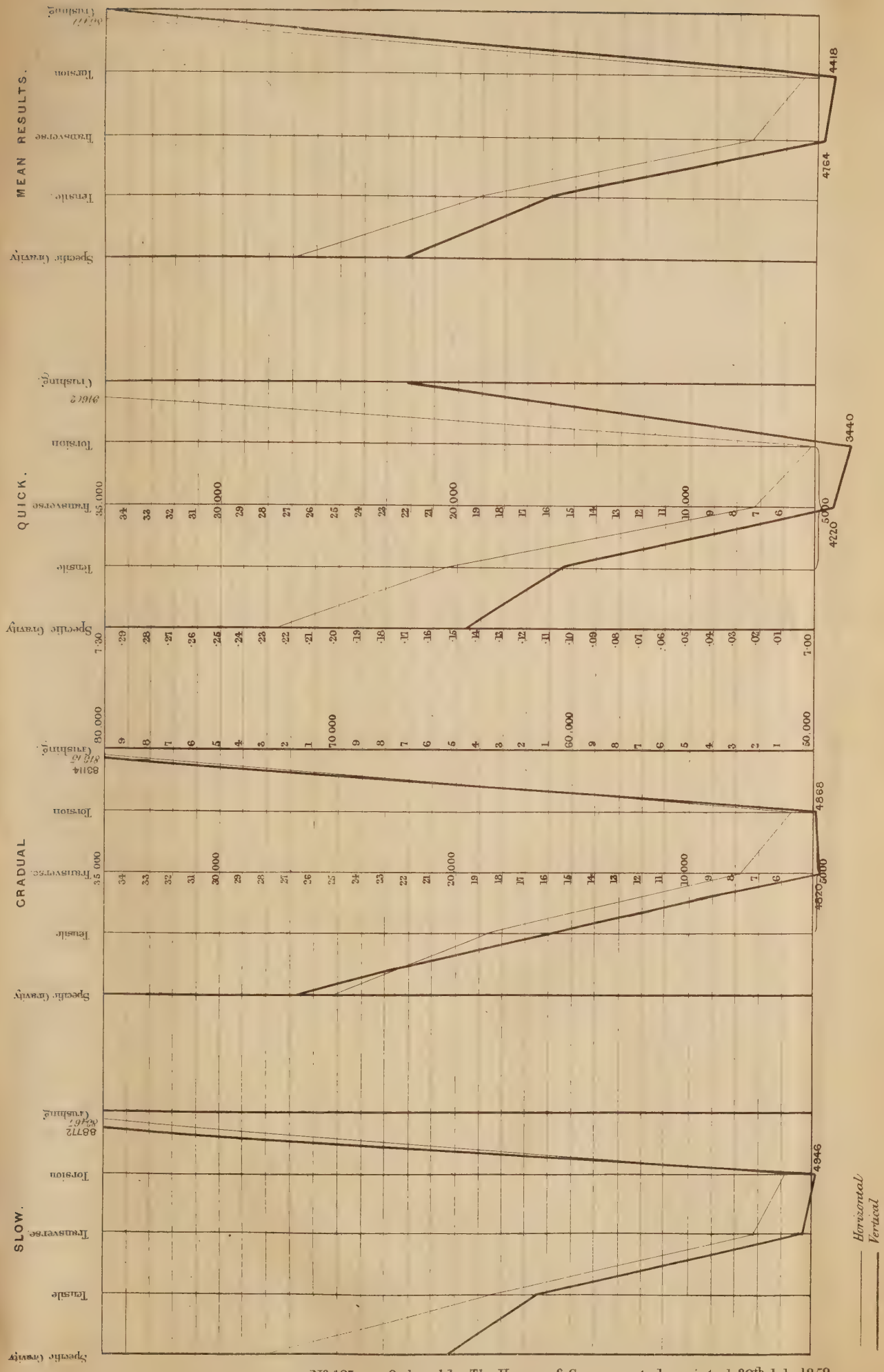
Harrison & Sons, Printers, London.
Henry Hansard, Printer.



No 497. Ordered by The House of Commons to be printed 30th July 1858

Standidge & Co Lithe. London

No. 3. HÆMATITE IRON COMPANY. PLATE No. 3.



No. 497. Ordered by The House of Commons to be printed, 30th July 1858.

Standidge & Co. Lithu. London

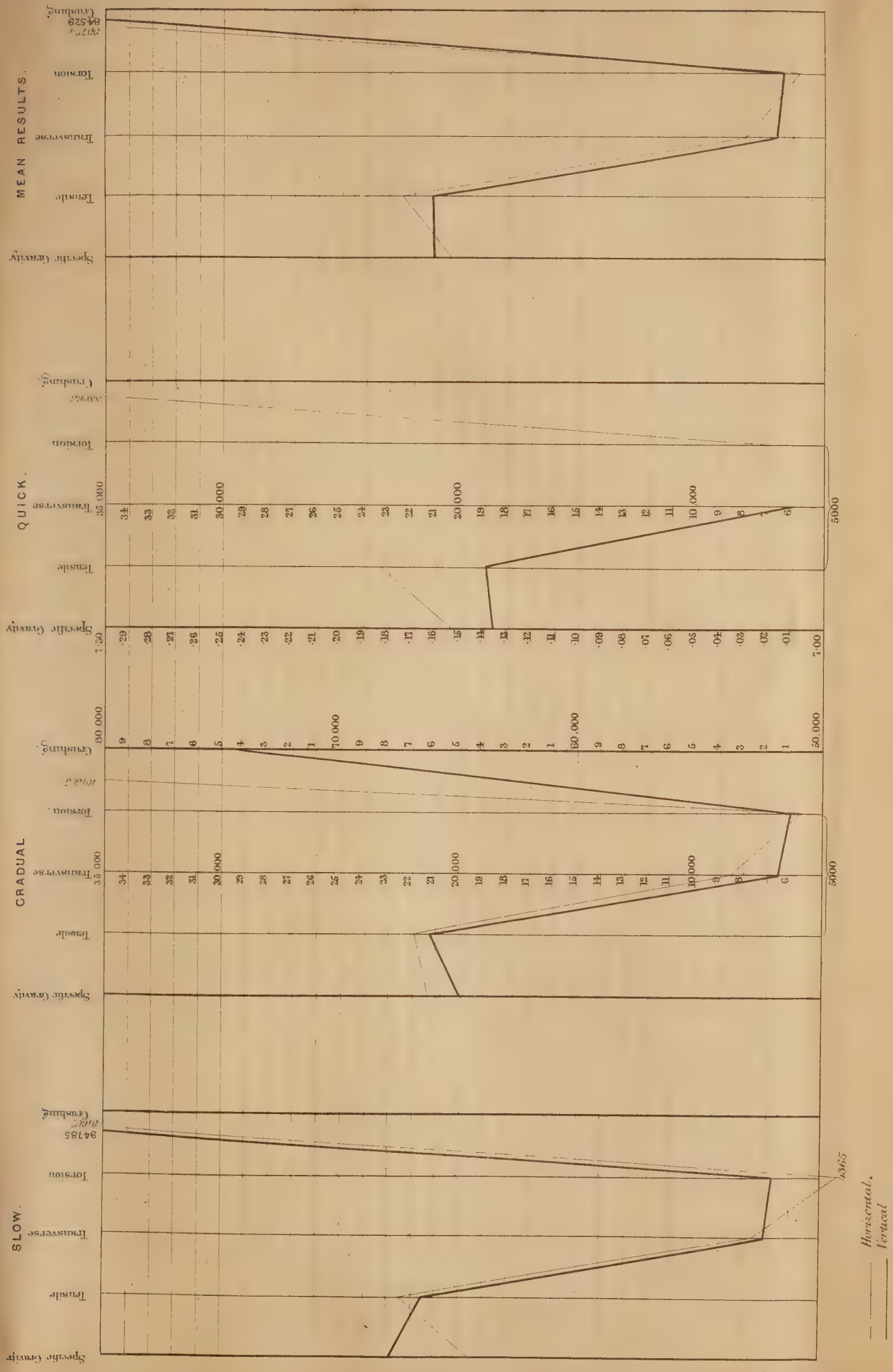
Henry Hansard, Printer

No. 19. MESSRS ATTWOOD, WEARDALE IRON COMPANY. PLATE Nº 4.

Nº 497. Ordered by The House of Commons to be printed, 30th July 1858.

Standidge & Co Lithos London

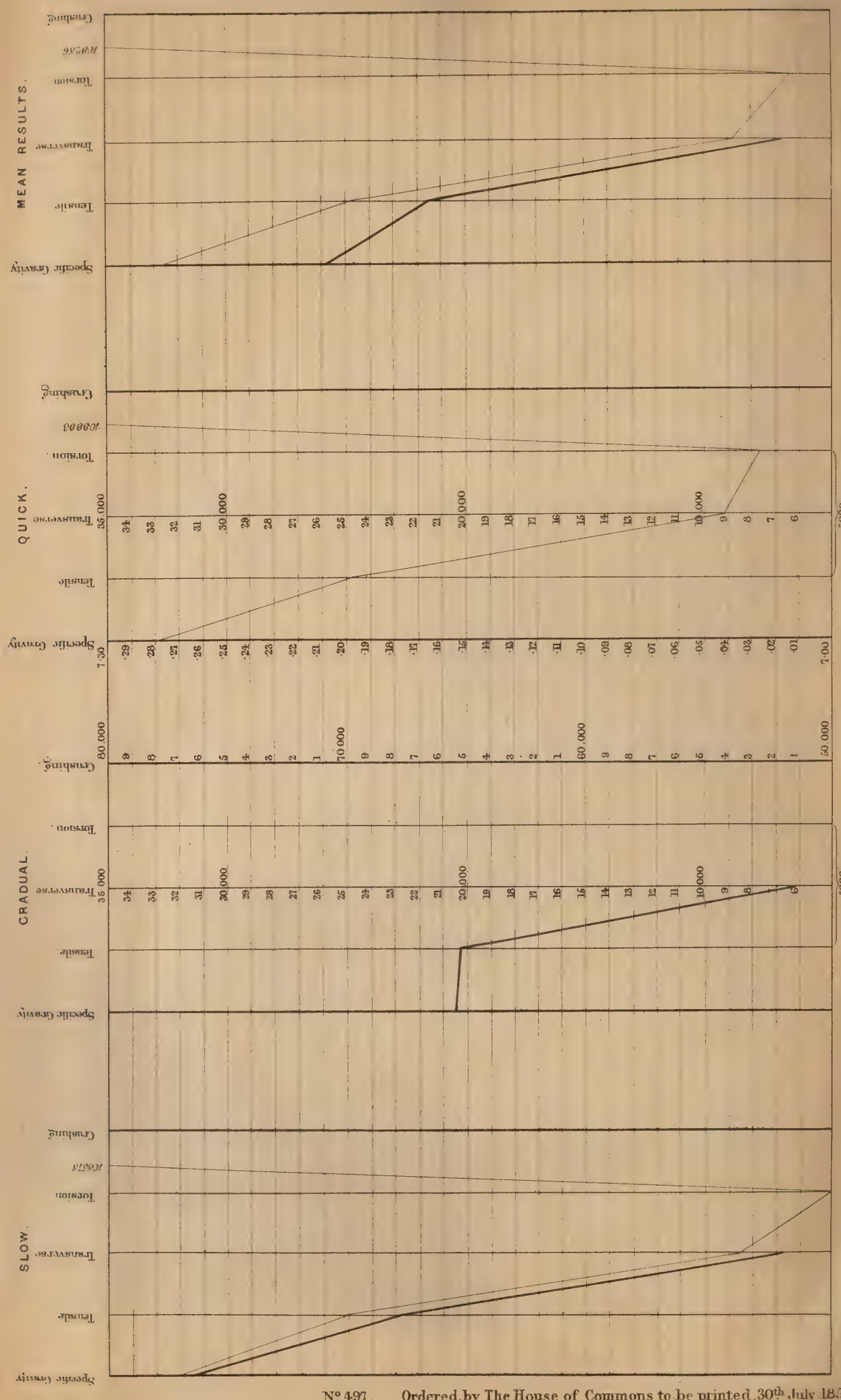
Henry Hansard Printer



Nº 497. Ordered by The House of Commons to be printed, 30th July 1858.

Cunnidge & Nº Lithº London

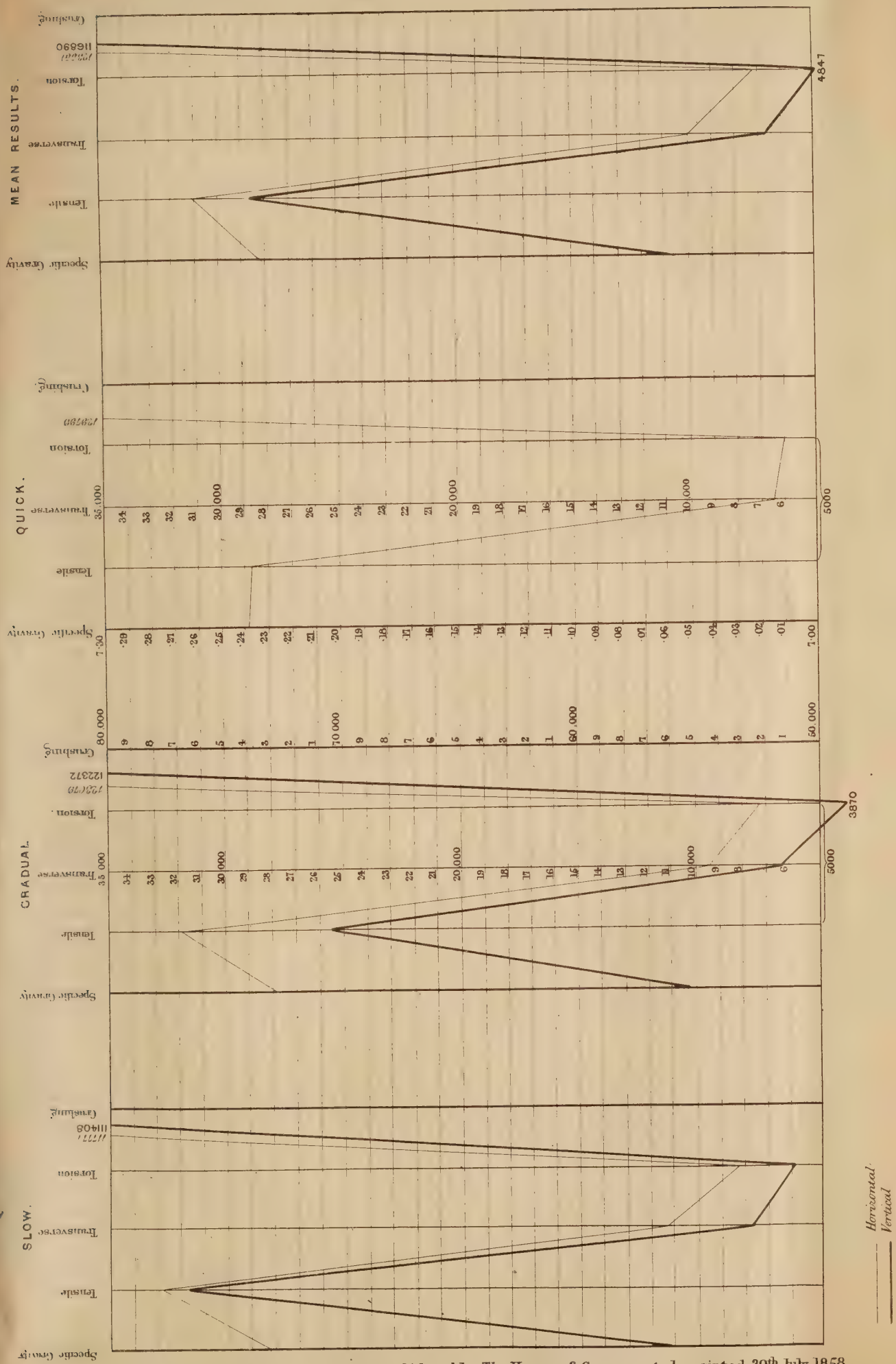
Henry Hansard, Printer.



Nº 497. Ordered by The House of Commons to be printed, 30th July 1858.

Standidge & Co Litho, London

Henry Hansard, Printer



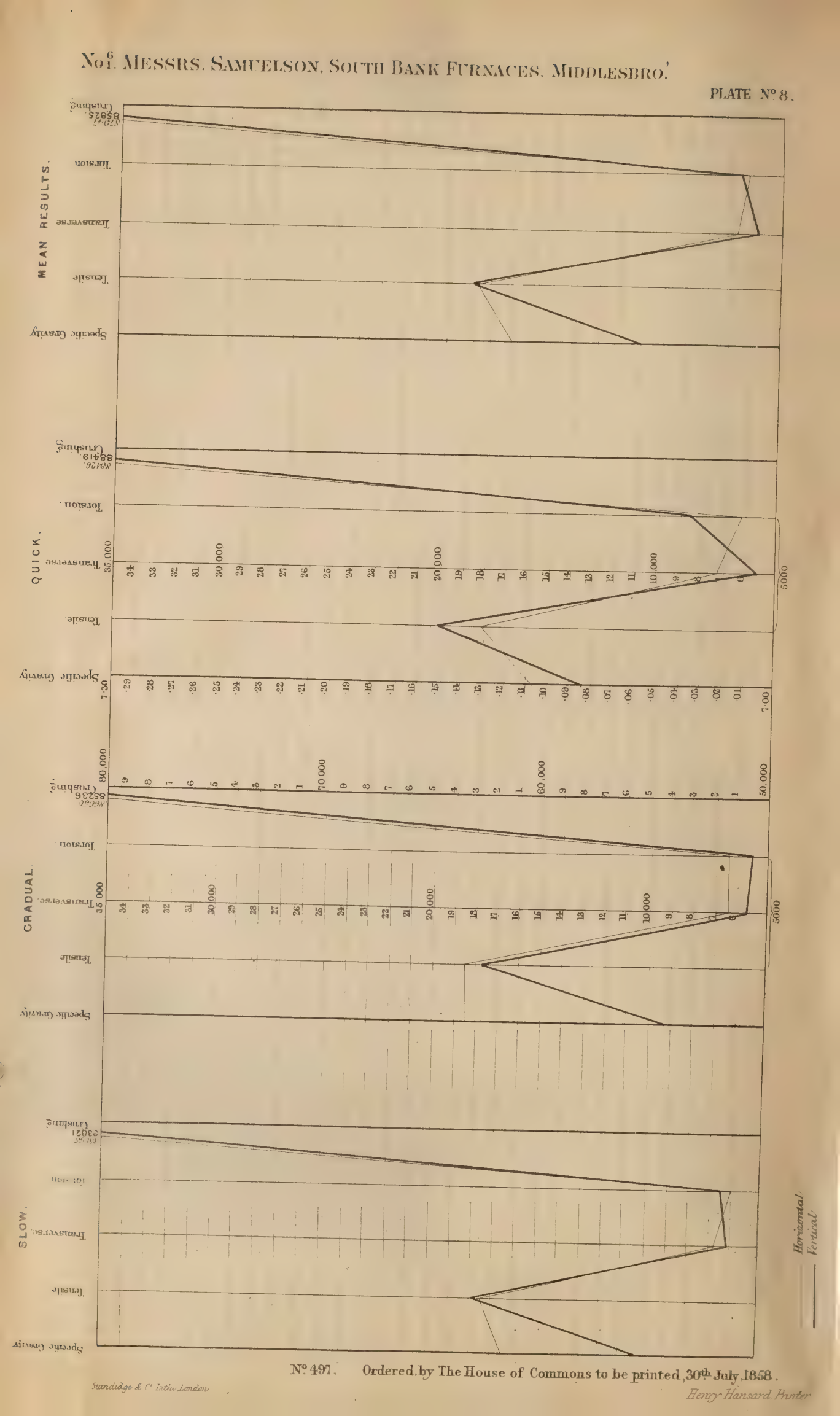
No 497. Ordered by The House of Commons to be printed, 30th July 1858.

Henry Hansard, Printer

Standidge & Co. Lithos, London

No. 6. MESSRS. SAMUELSON, SOUTH BANK FURNACES, MIDDLESBRO.'

PLATE No 8.



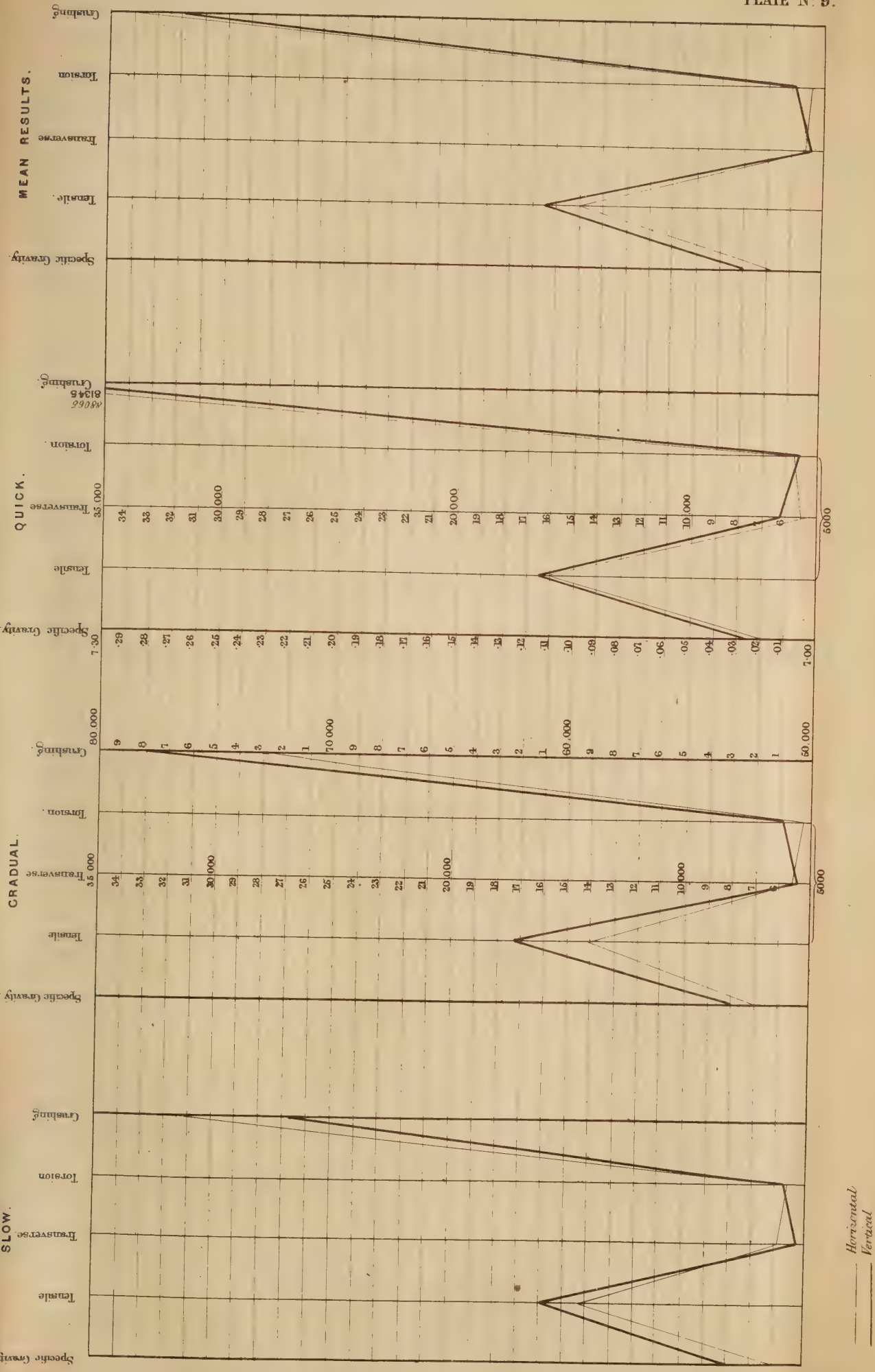
No. 497. Ordered by The House of Commons to be printed, 30th July, 1858.

Standidge & Co. Lithrs London.

Henry Hansard, Printer

No $\frac{6}{2}$. MESSRS. SAMUELSON, SOUTH BANK FURNACES, MIDDLESBRO'.

PLATE Nº 9.



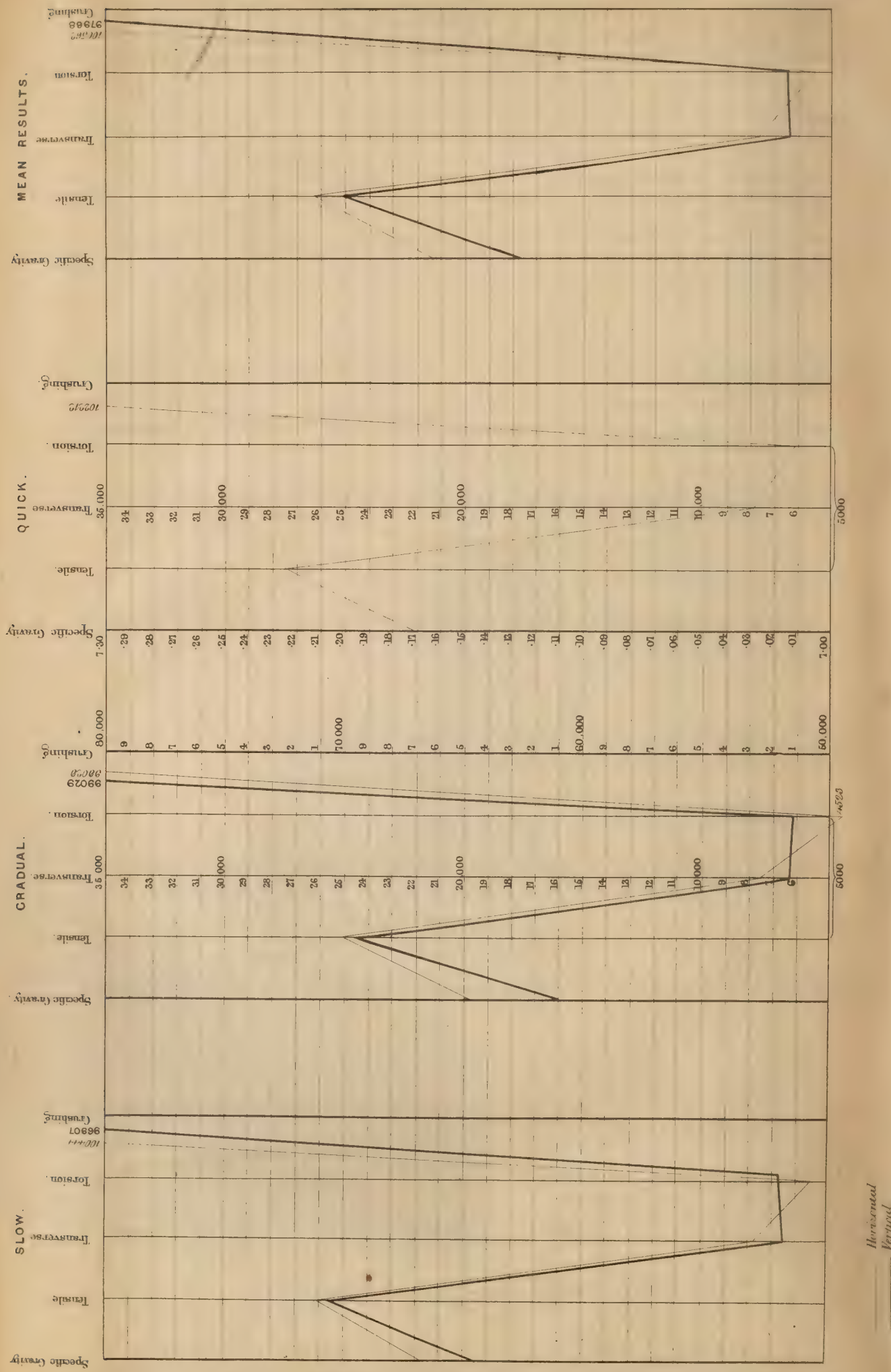
Nº 497. Ordered by The House of Commons to be printed, 30th July 1858.

Standidge & Cº Litho, London

Henry Hansard, Printer

No. 15. MESSRS HOLDSWORTH, BENNINGTON & BYERS, STOCKTON IRON WORKS.

PLATE Nº 10.



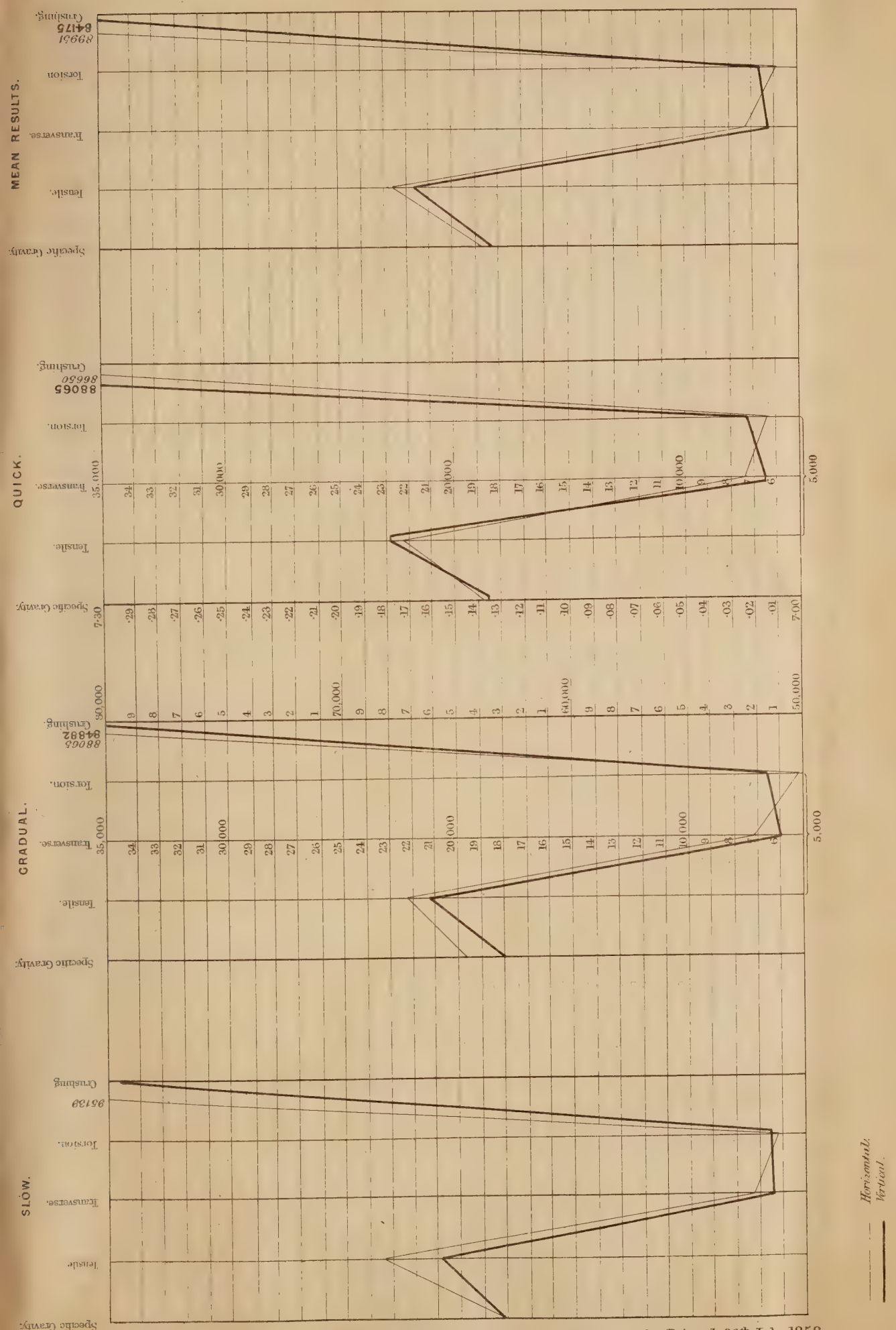
Nº 497. Ordered by The House of Commons to be printed, 30th July 1858.

Standidge & Co Lith. London.

Henry Hansard, Printer

Nº 15/2. Messrs Holdsworth, Bennington & Byers, Iron Works.

PLATE Nº II.



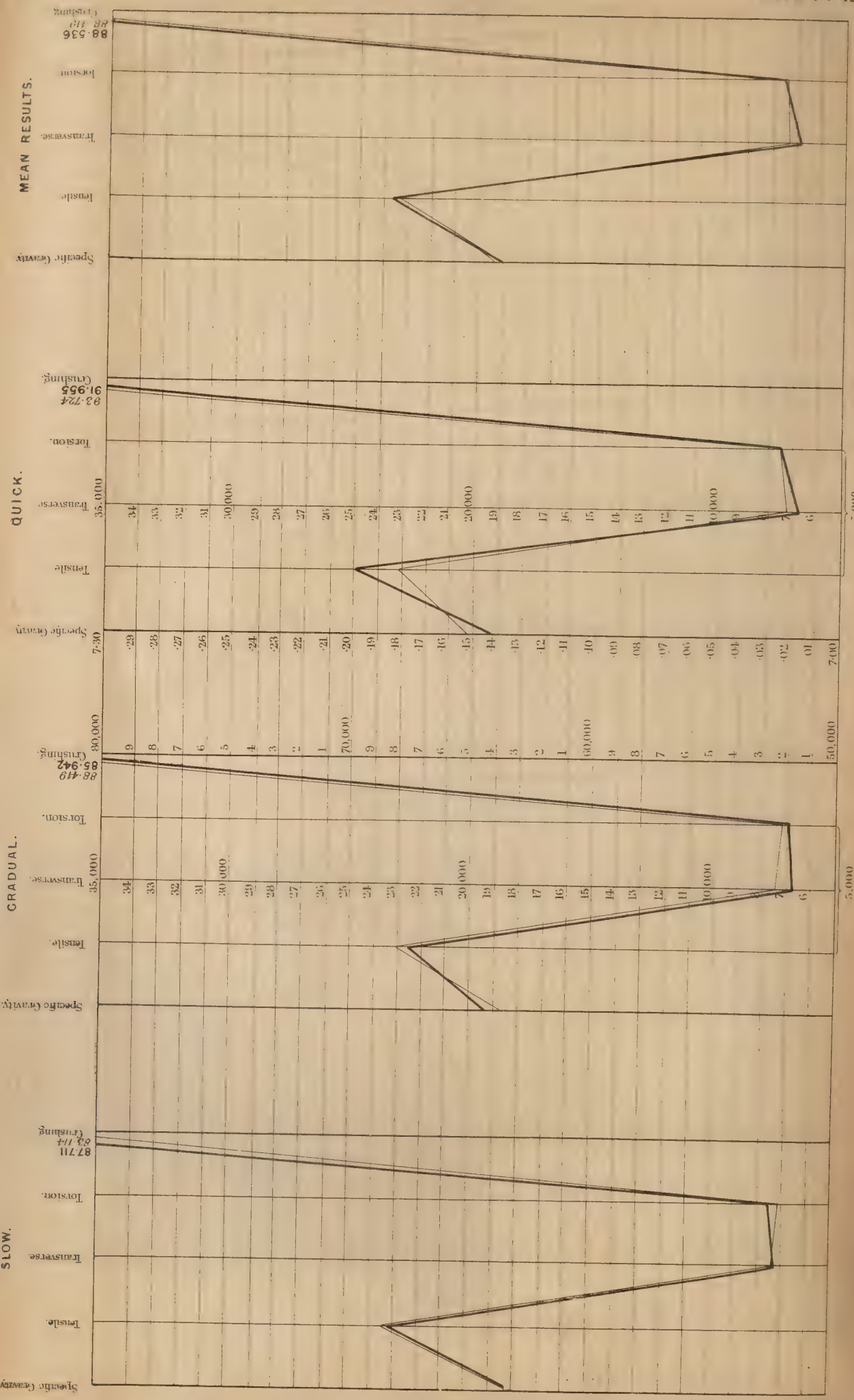
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall. Bro's Litho. Castle St, Holborn.

Henry Hansard, Printer.

No. 8 1. Messrs Needham & Co Butterley Iron Works.

PLATE No. 12.



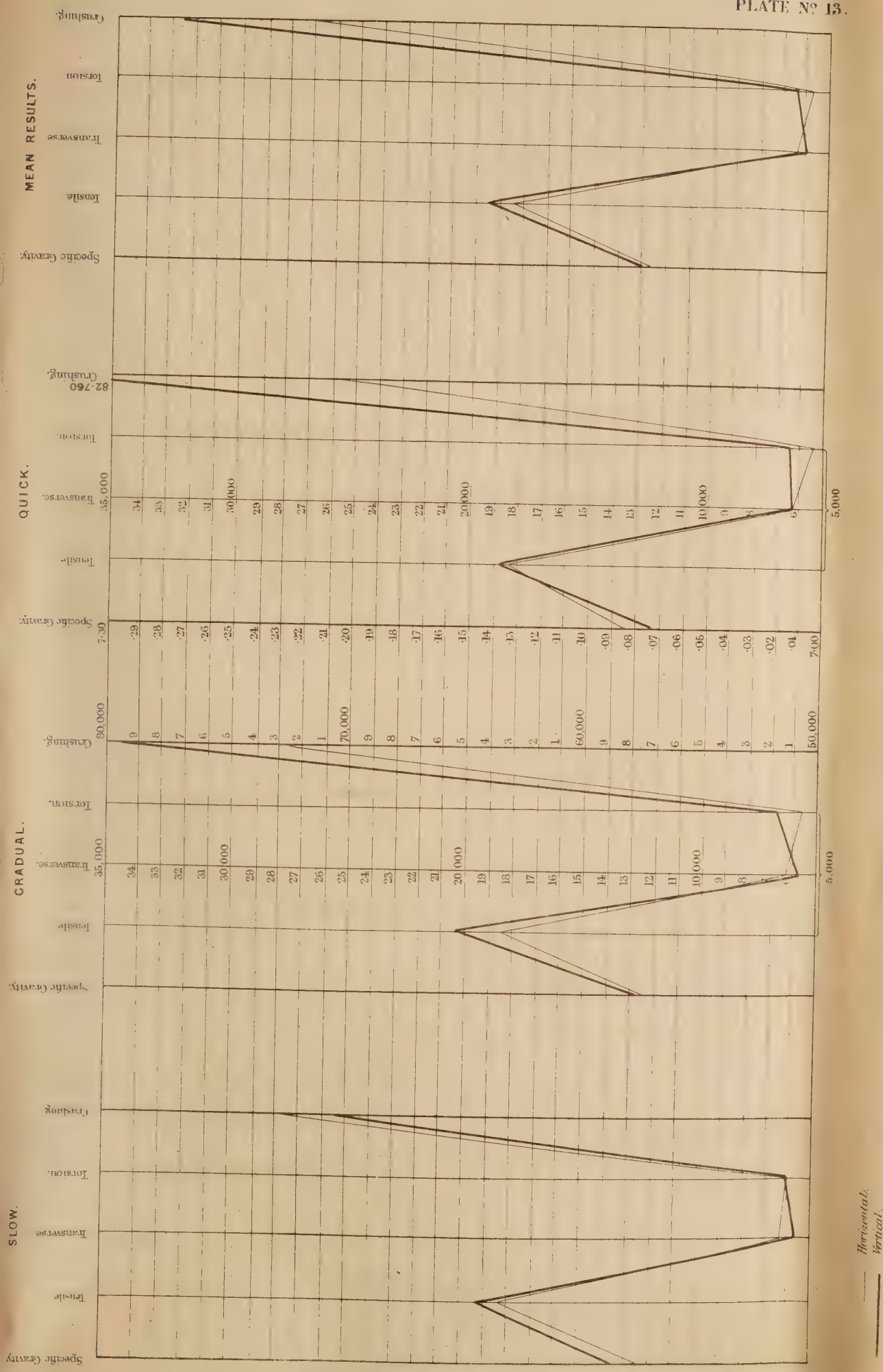
No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers Litho Castle St. Holborn

Henry Hansard, Printer

Nº 8/2 Messrs Needham & Co Butterley Iron Works.

PLATE Nº 13.



Horizontal.
Vertical.

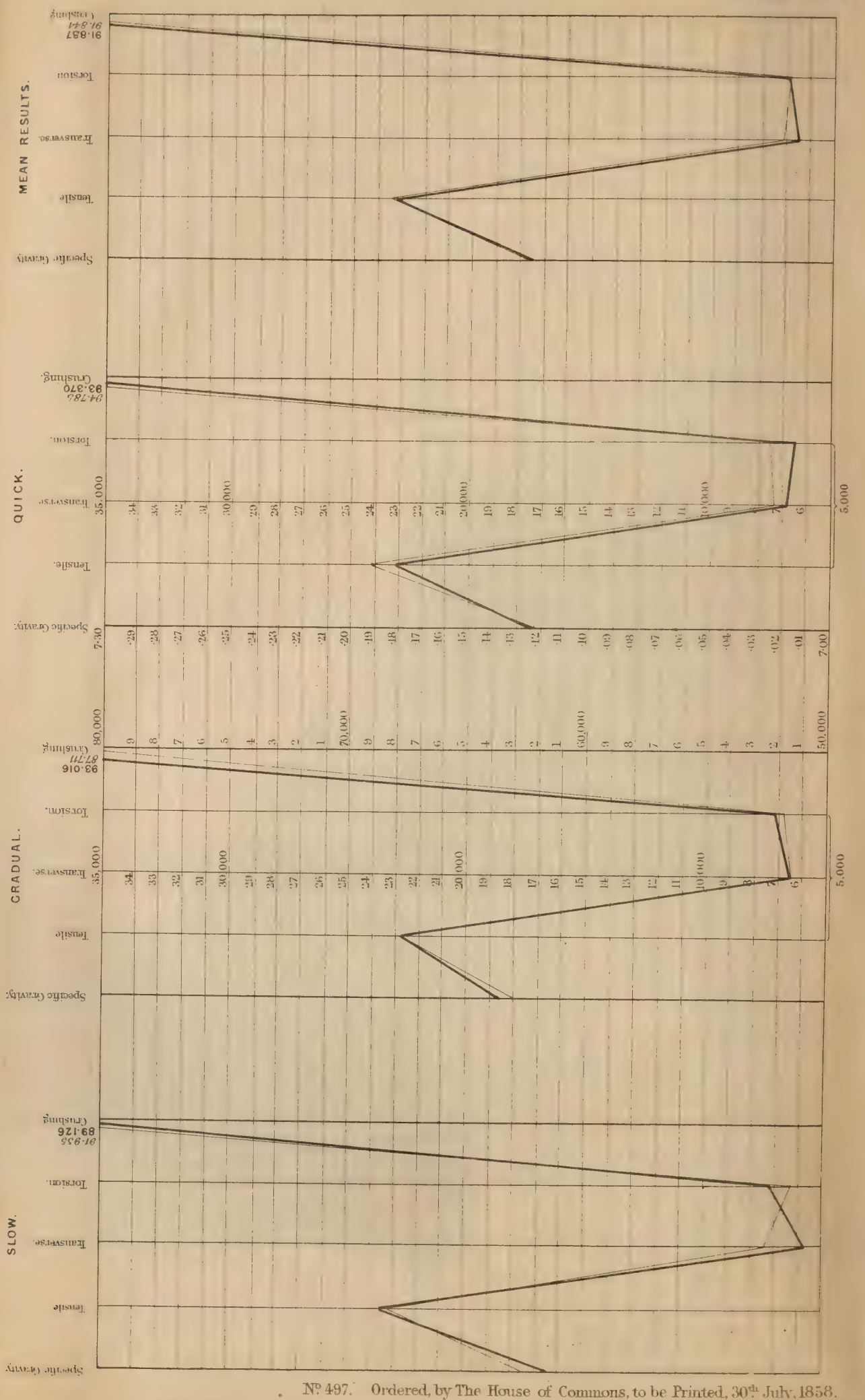
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers Tudor Castle 31, Holborn.

Henry Hansard, Printer.

No. 8/3 Messrs Needham & Co Butterley, Iron Works .

PLATE No 11.

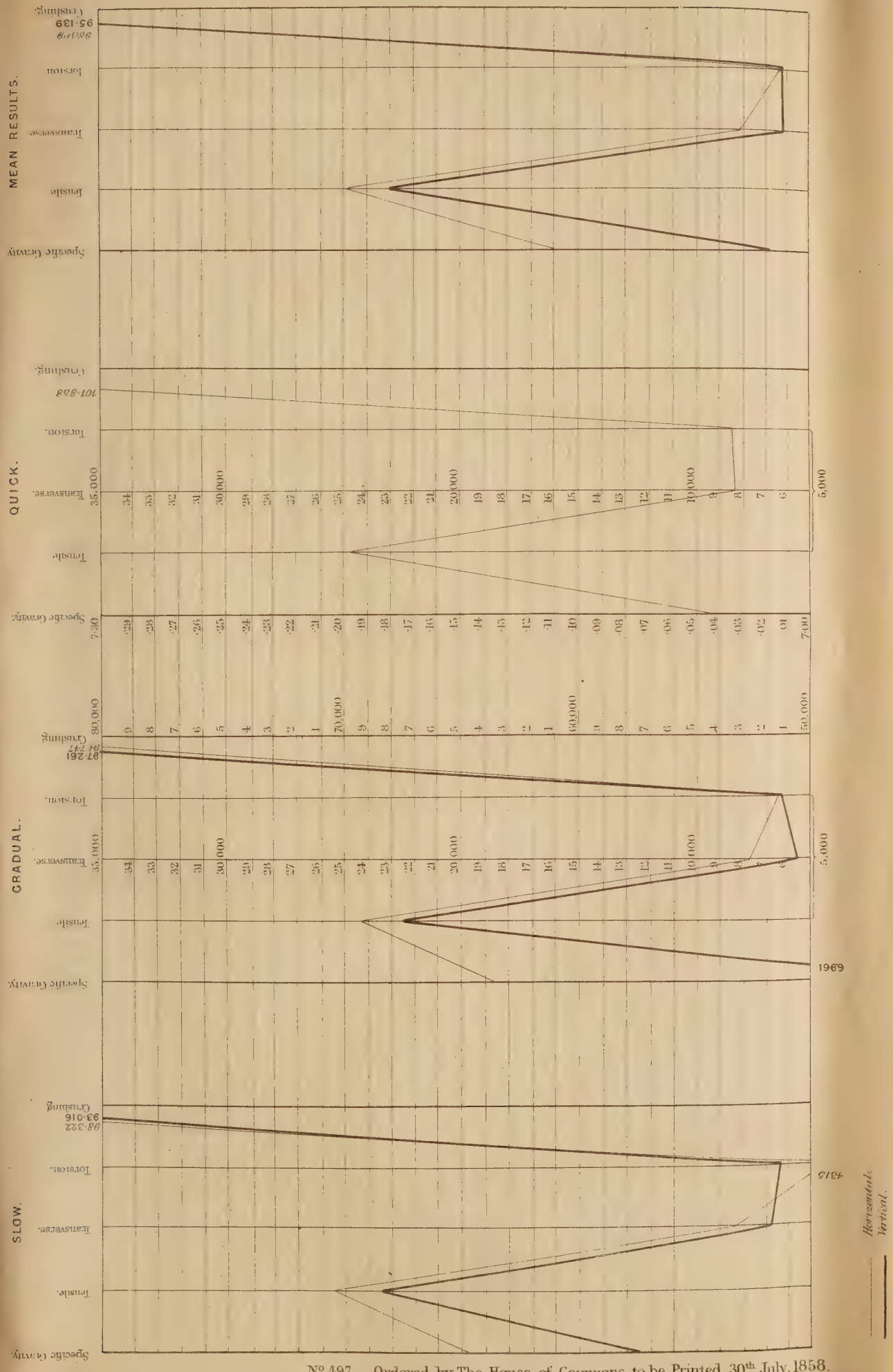


No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Kell Bros Lithe Castle St, Holborn.

Nº 8 4. Messrs Needham & Cº Butterley Iron Works.

PLATE Nº15.



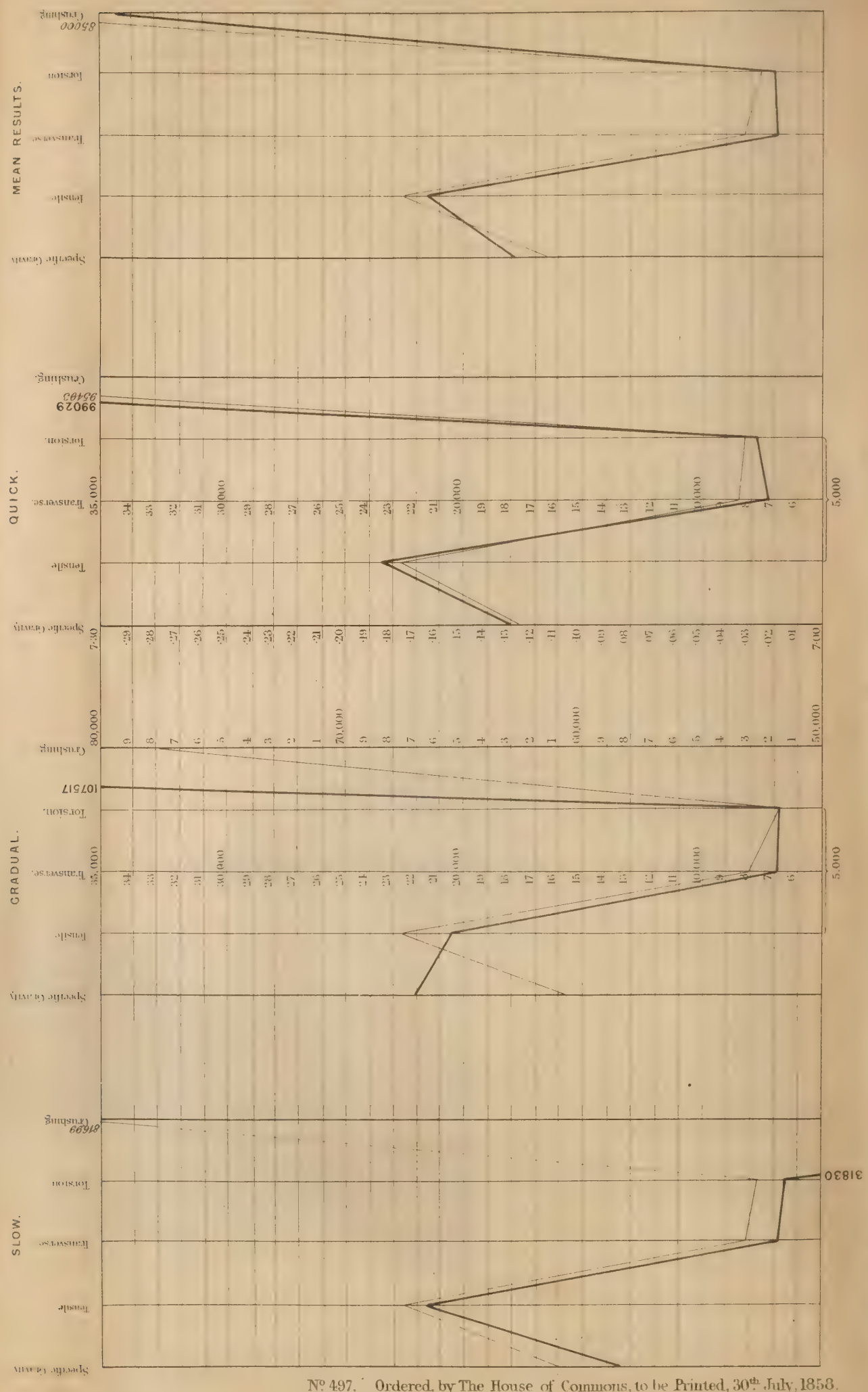
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bro's Litho. Castle St, Holborn.

Henry Hansard, Printer

Nº 1/1. Messrs Whitehouse, West Hallum Iron Works, Ilkeston.

PLATE Nº16.



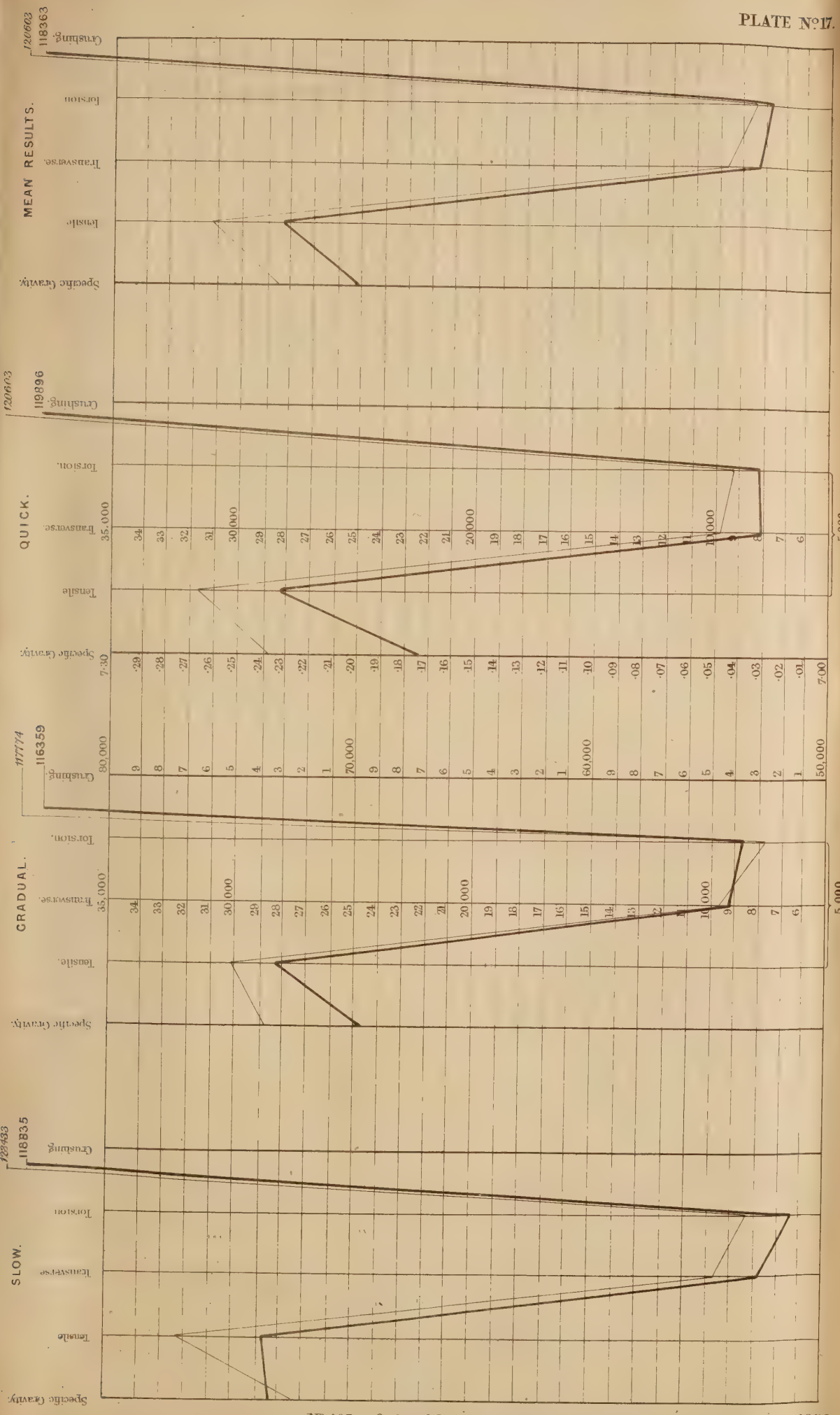
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hill Brothers Lithe Castle St. Holborn

Henry Hansard, Printer

Nº ½. Messrs Whitehouse, West Hallum Iron Works, Ilkeston.

PLATE Nº17.



Horizontal.
Vertical.

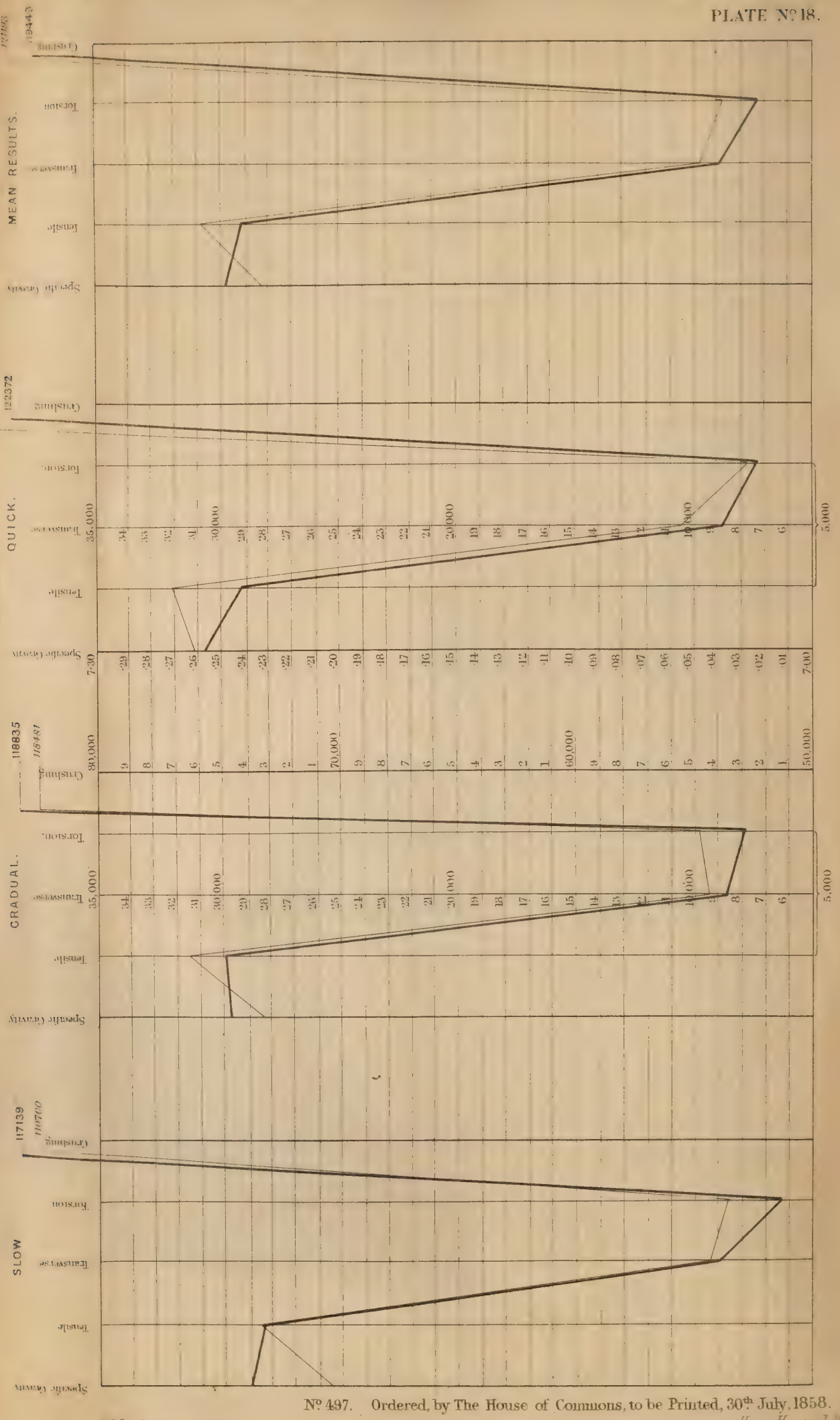
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bros Litho. Castle St, Holborn.

Henry Hansard, Printer

Nº ⅓. Messrs Whitehouse, West Hallum Iron Works, Ilkeston.

PLATE Nº 18.



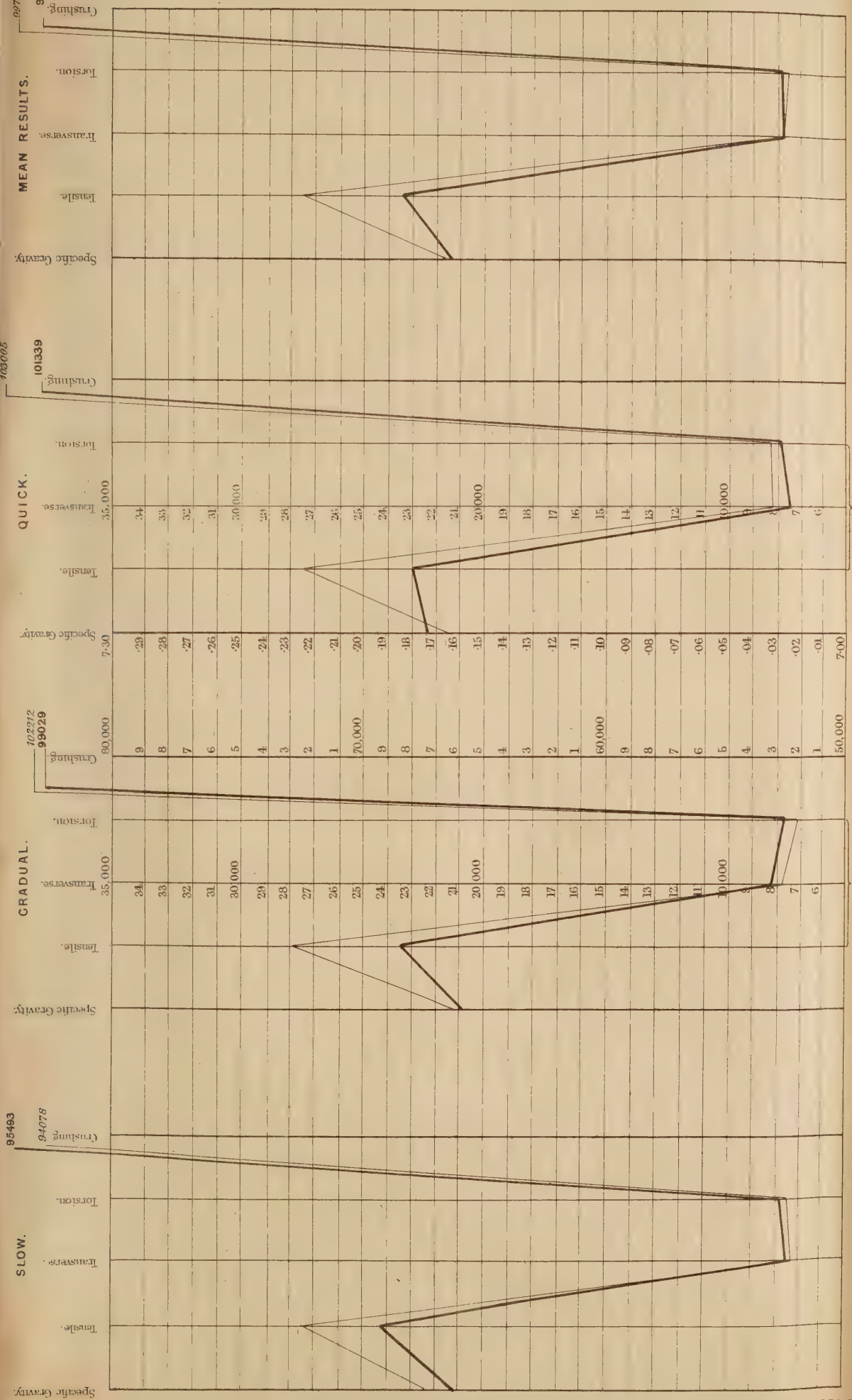
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Kell Bros Litho Castle St, Holborn

Henry Hansard, Printer

Nº 1/4. Messrs Whitehouse, West Hallum Iron Works, Ilkeston.

PLATE Nº 19.



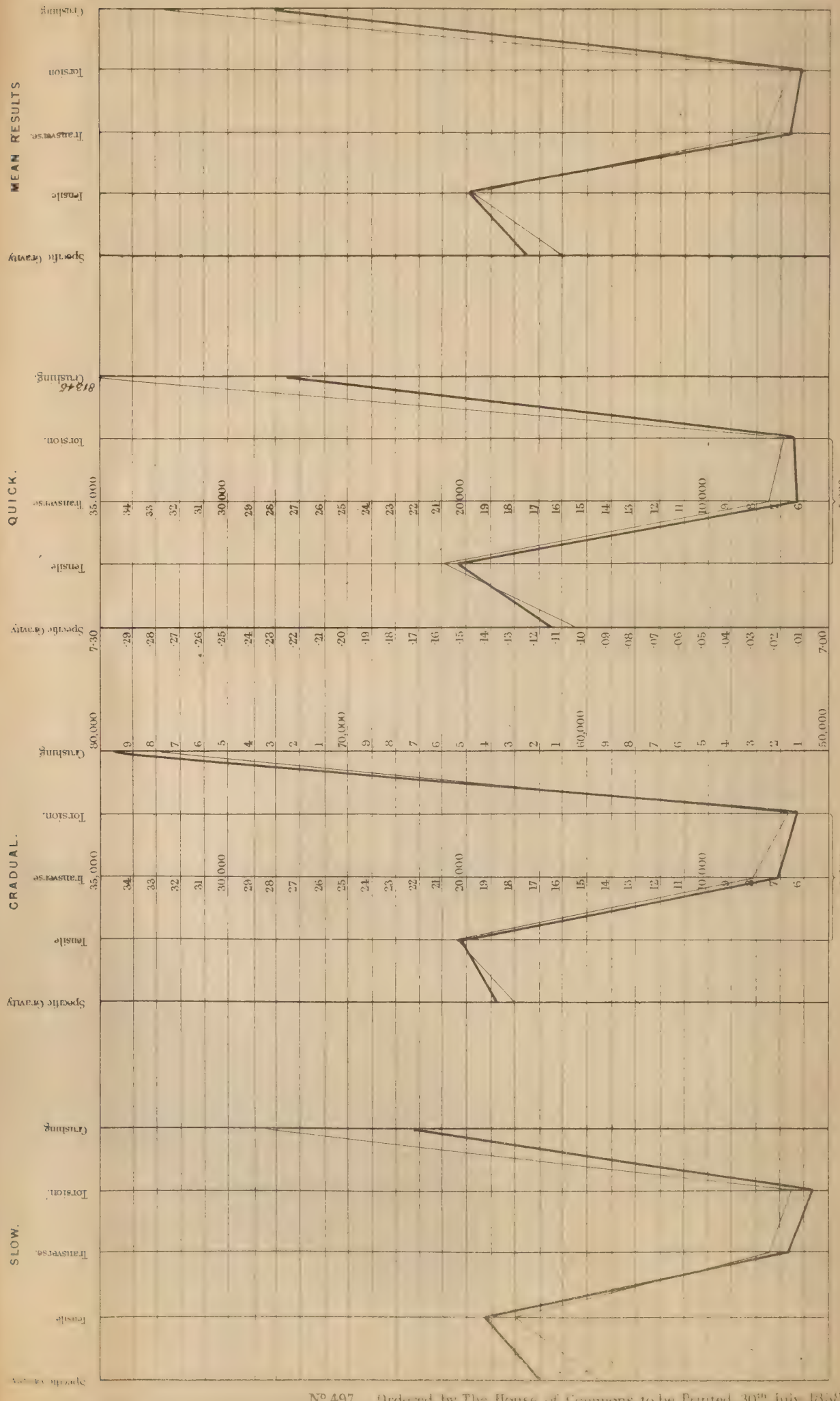
Horizontal.
Vertical.

Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bros Litho Castle St, Holborn

Henry Hansard, Printer

Nº 1/5. Messrs Whitehouse, West Hallum Iron Works. Ilkeston.

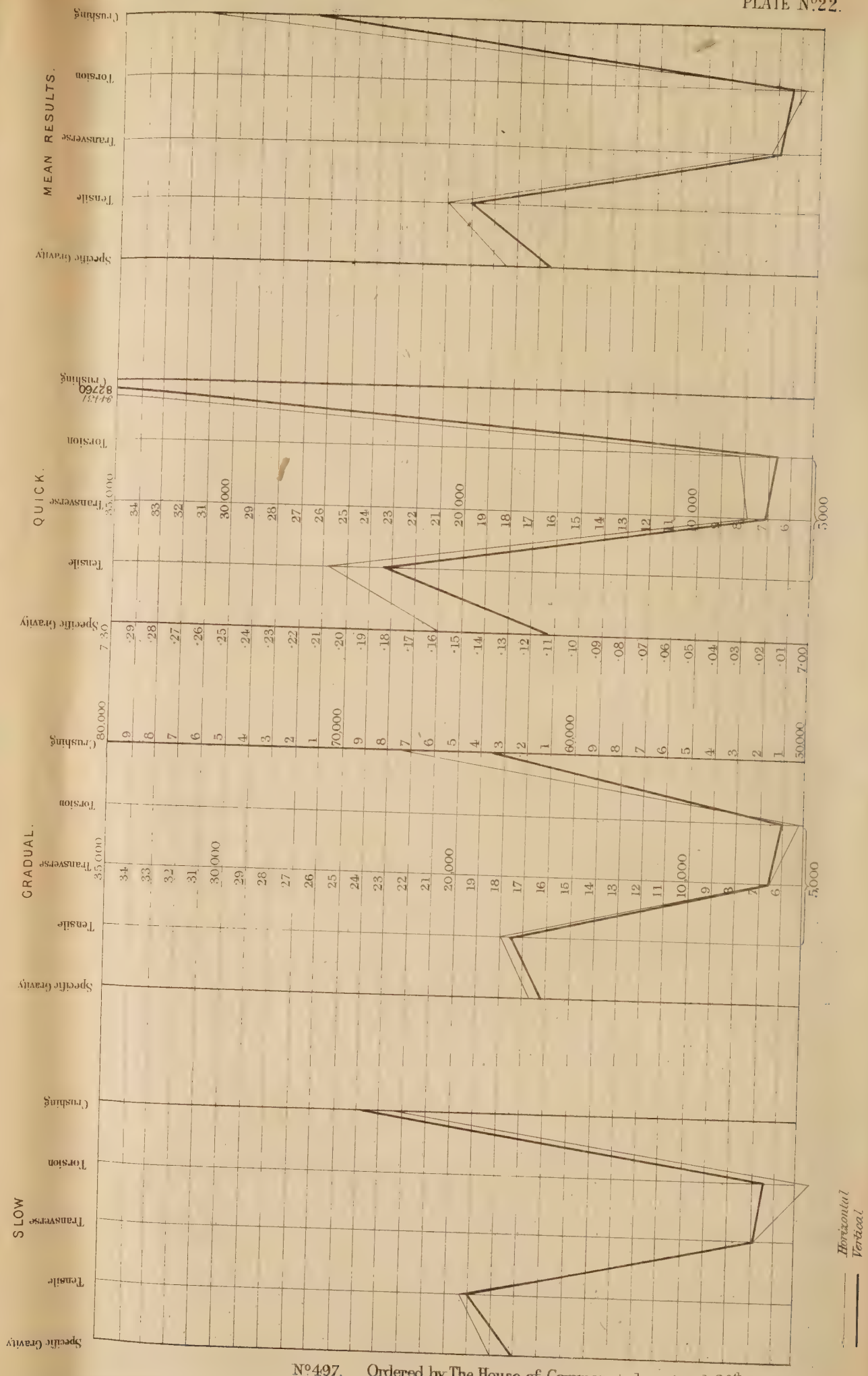


Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858

Hall Bros Litho Castle St, Holborn

Nº 1 MESSRS. GRAZEBROOK, NETHERTON IRON WORKS, NEAR DUDLEY.

PLATE Nº22.



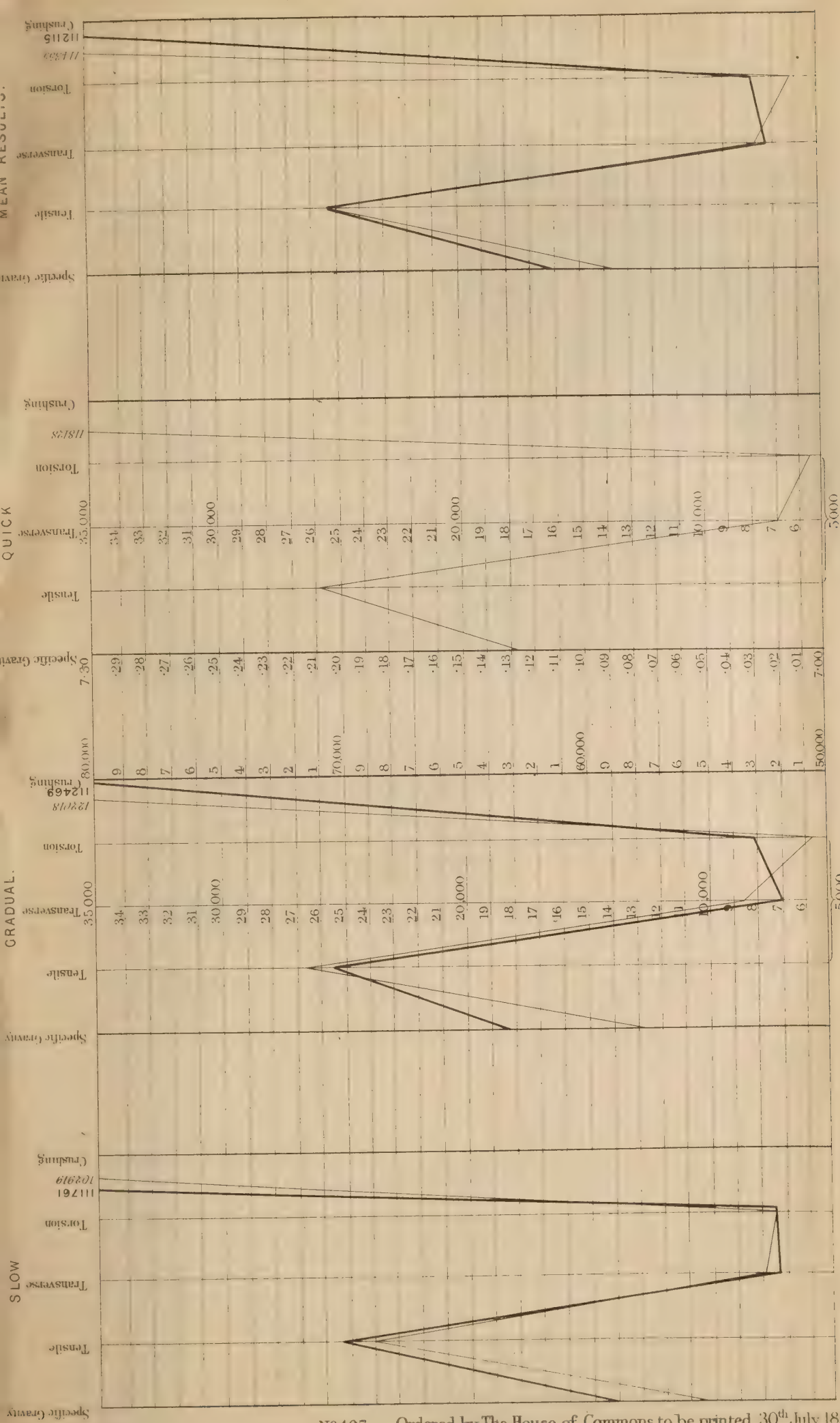
Nº497. Ordered by The House of Commons to be printed, 30th July, 1858.

Lane & Son Lith^rs to the Queen

Henry Hansard, Printer.

Nº 17/1 MESSRS. WILLIAMSON, GOLDENDALE IRON WORKS.

PLATE Nº21.

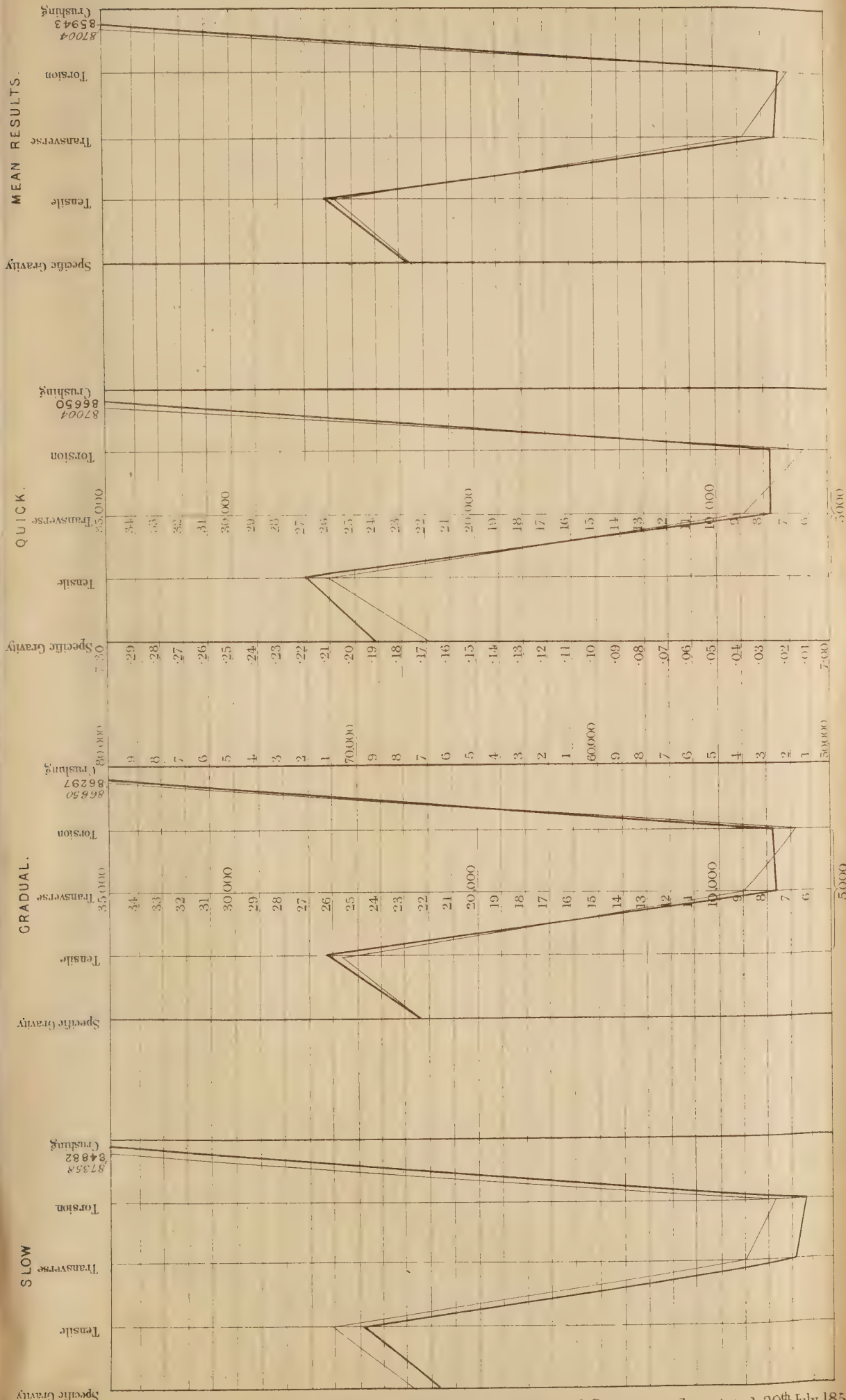


Nº497. Ordered by The House of Commons to be printed, 30th July 1858

Day & Son Lith.rs to the Queen

Hansard, Strand

Nº 2/2 MESSRS. GRAZEBROOK, NETHERTON IRON WORKS, NEAR DUDLEY.



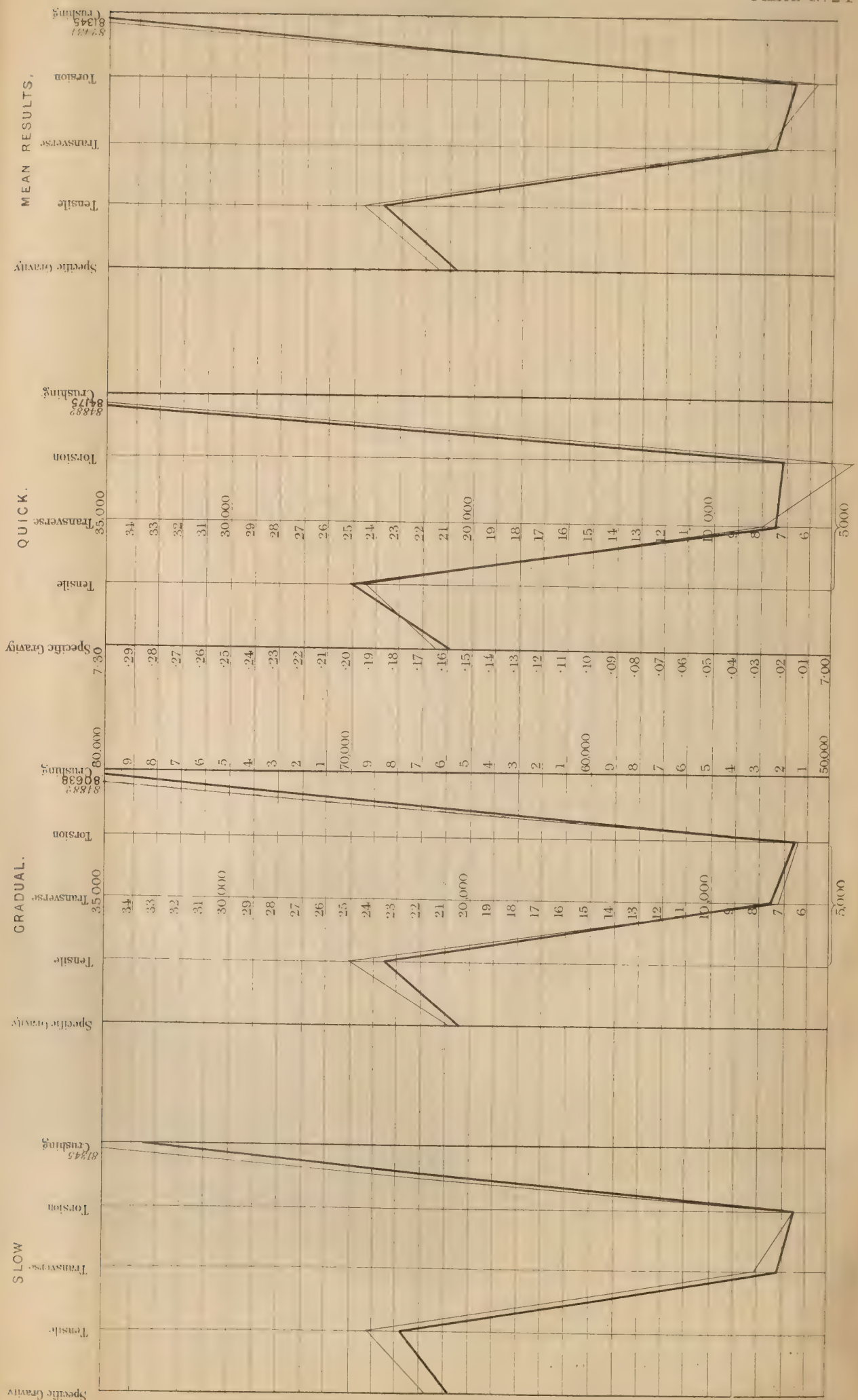
Nº497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith.rs to the Queen

Henry Tansard Printer

Nº 2/3 MESSRS. GRAZEBROOK, NETHERTON IRON WORKS, NEAR DUDLEY.

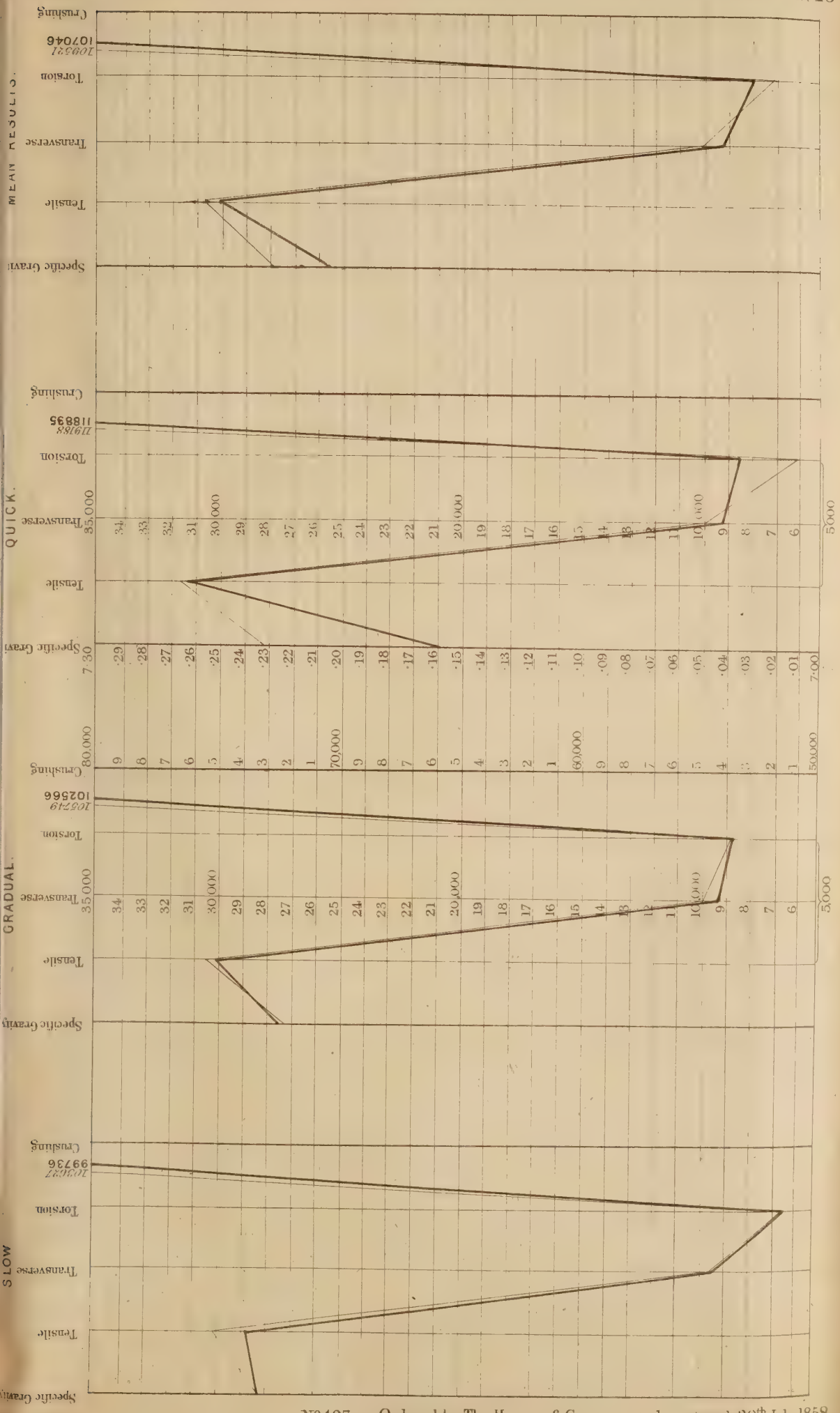
PLATE Nº 24



Nº497. Ordered by The House of Commons to be printed, 30th July, 1858.

Dow & Son Lith^rs to the Queen

Henry Hansard, Printer



Nº497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith.rs to the Queen

Henry Tuck Printer

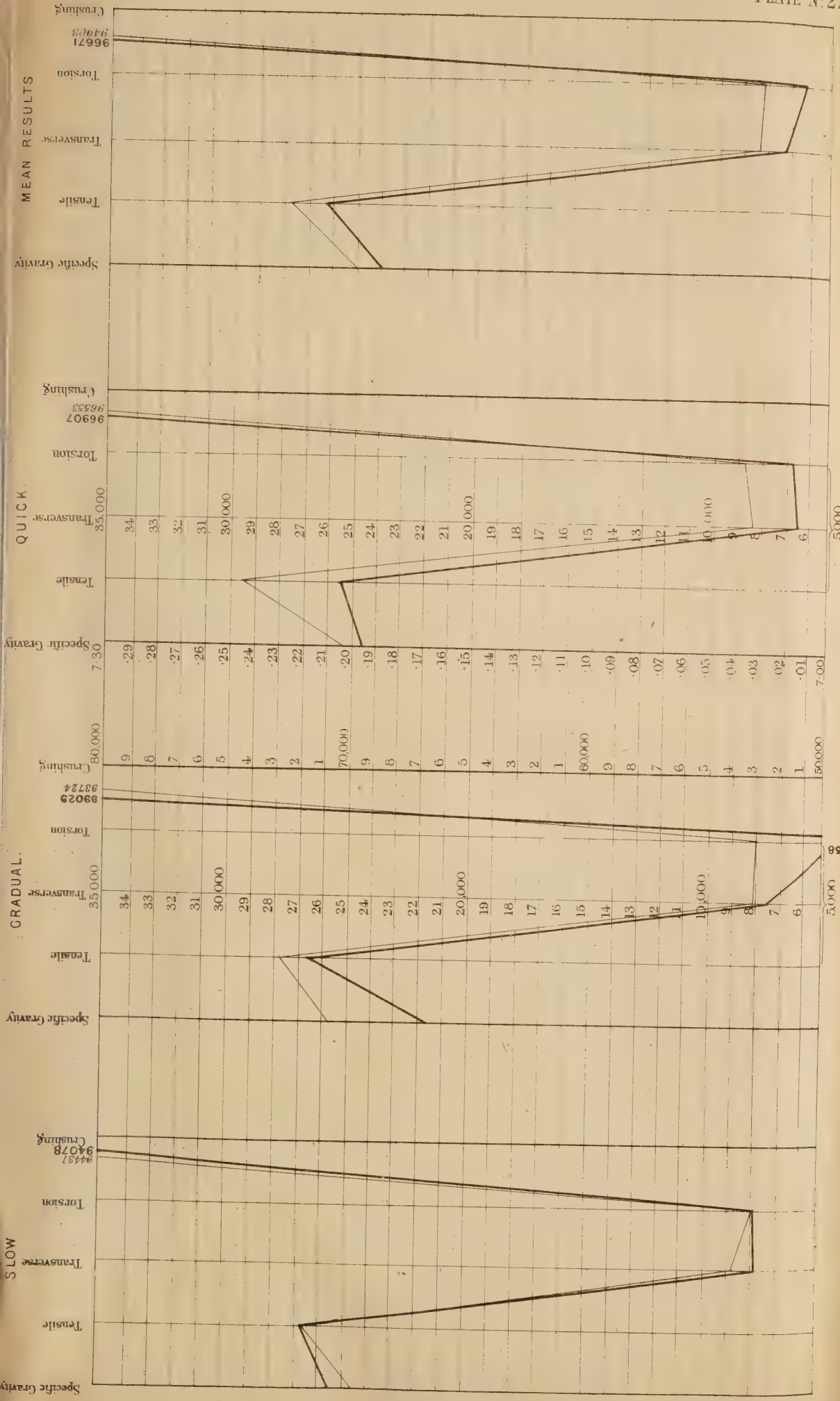
Nº 2 MESSRS. GRAZEBROOK, NETHERTON IRON WORKS, NEAR DUDLEY.

PLATE Nº 26.

Nº 497. Ordered by The House of Commons to be printed, 30th July 1858.

N° 10/1 MESSRS. EVERS AND MARTIN, PARK-HEAD FURNACES, NEAR DUDLEY.

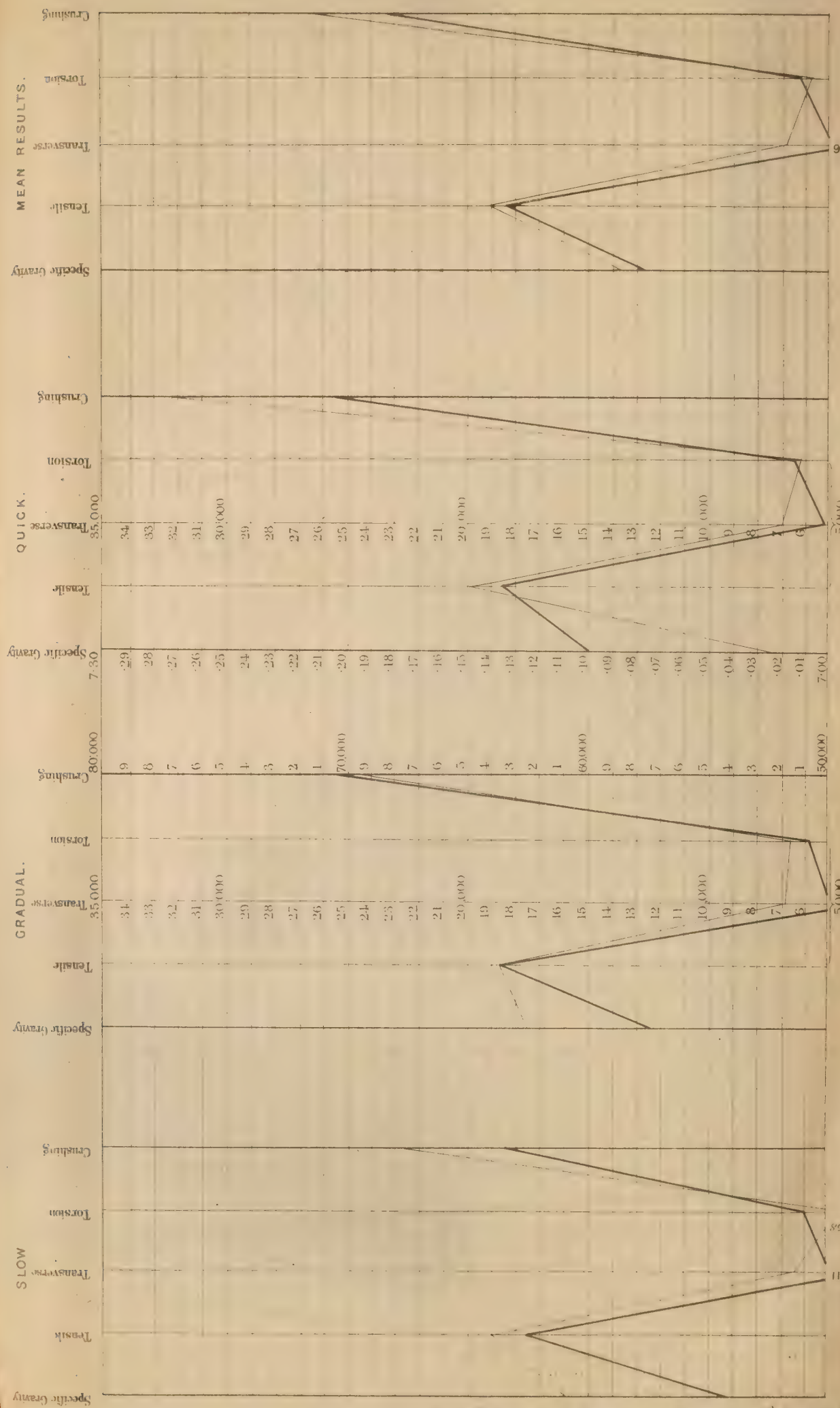
PLATE N°27.



N°497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith.rs to the Queen

Henry Hansard, Printer

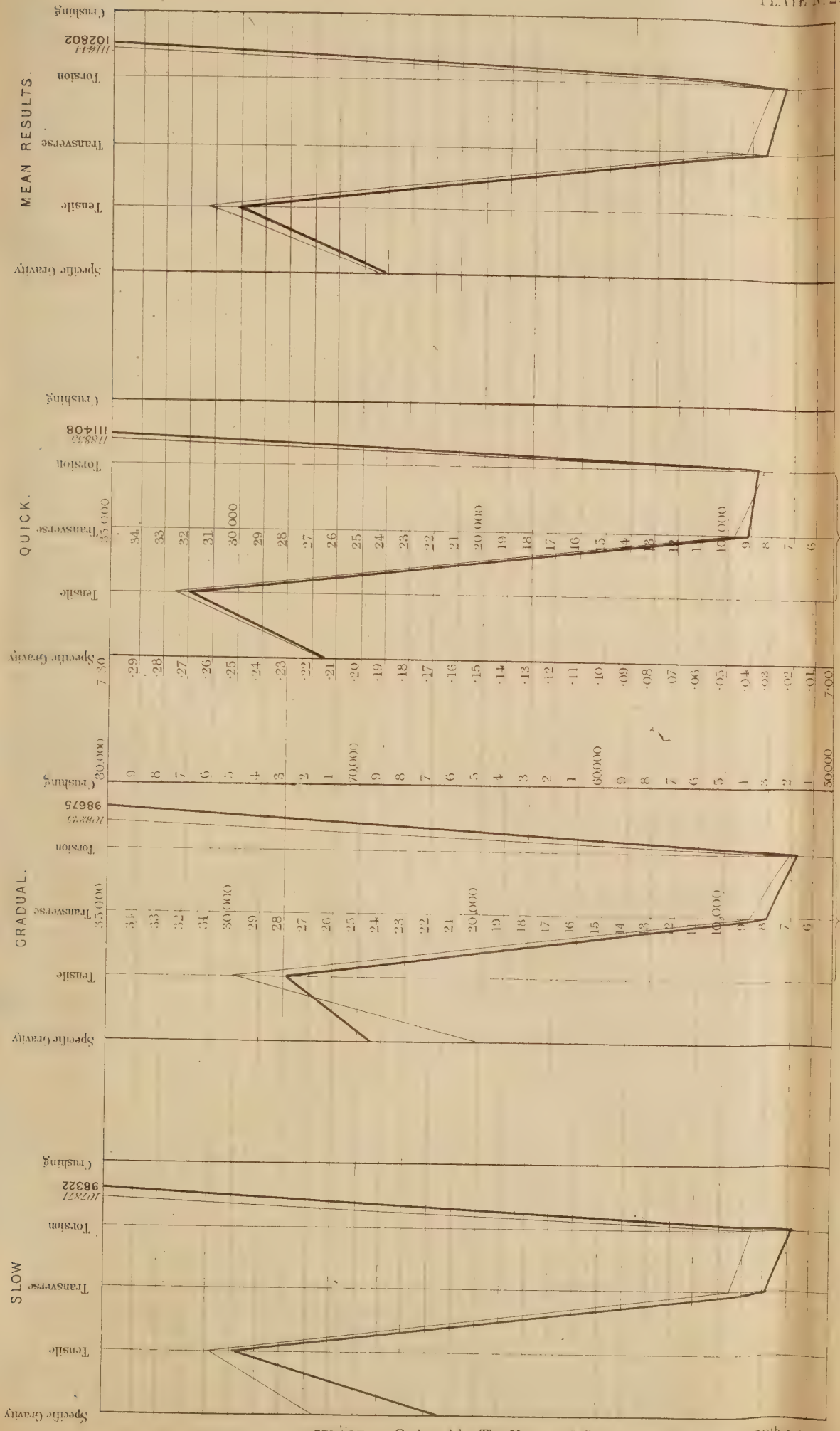


Nº497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith. to the Queen

N° $\frac{10}{3}$ MESSRS. EVERS AND MARTIN, PARK-HEAD FURNACES, NEAR DUDLEY.

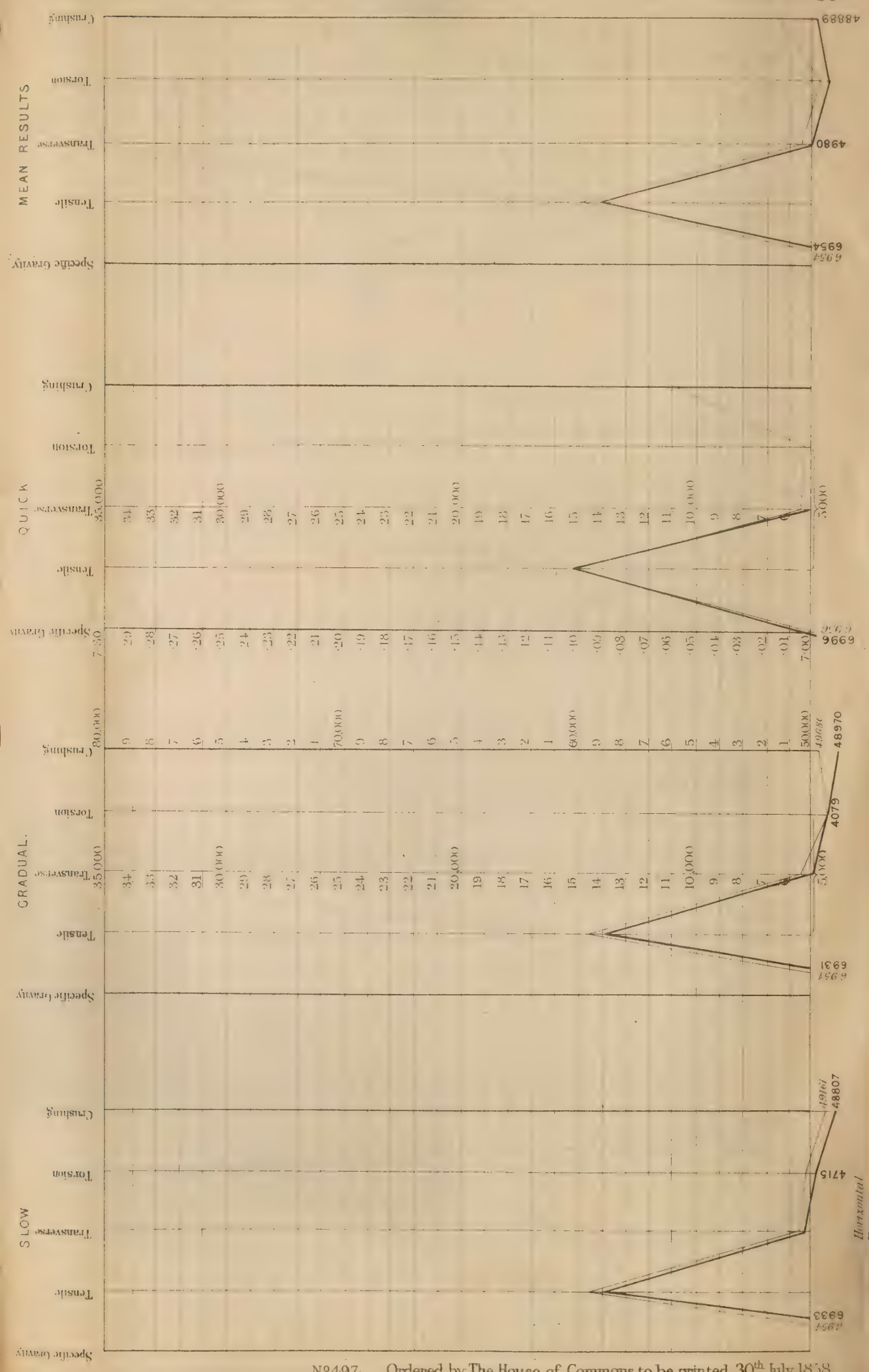
PLATE N°29.



N°497. Ordered by The House of Commons to be printed, 30th July, 1858.

N° 7 MESSRS. BADGER & C° OLD HILL FURNACES, NEAR DUDLEY.

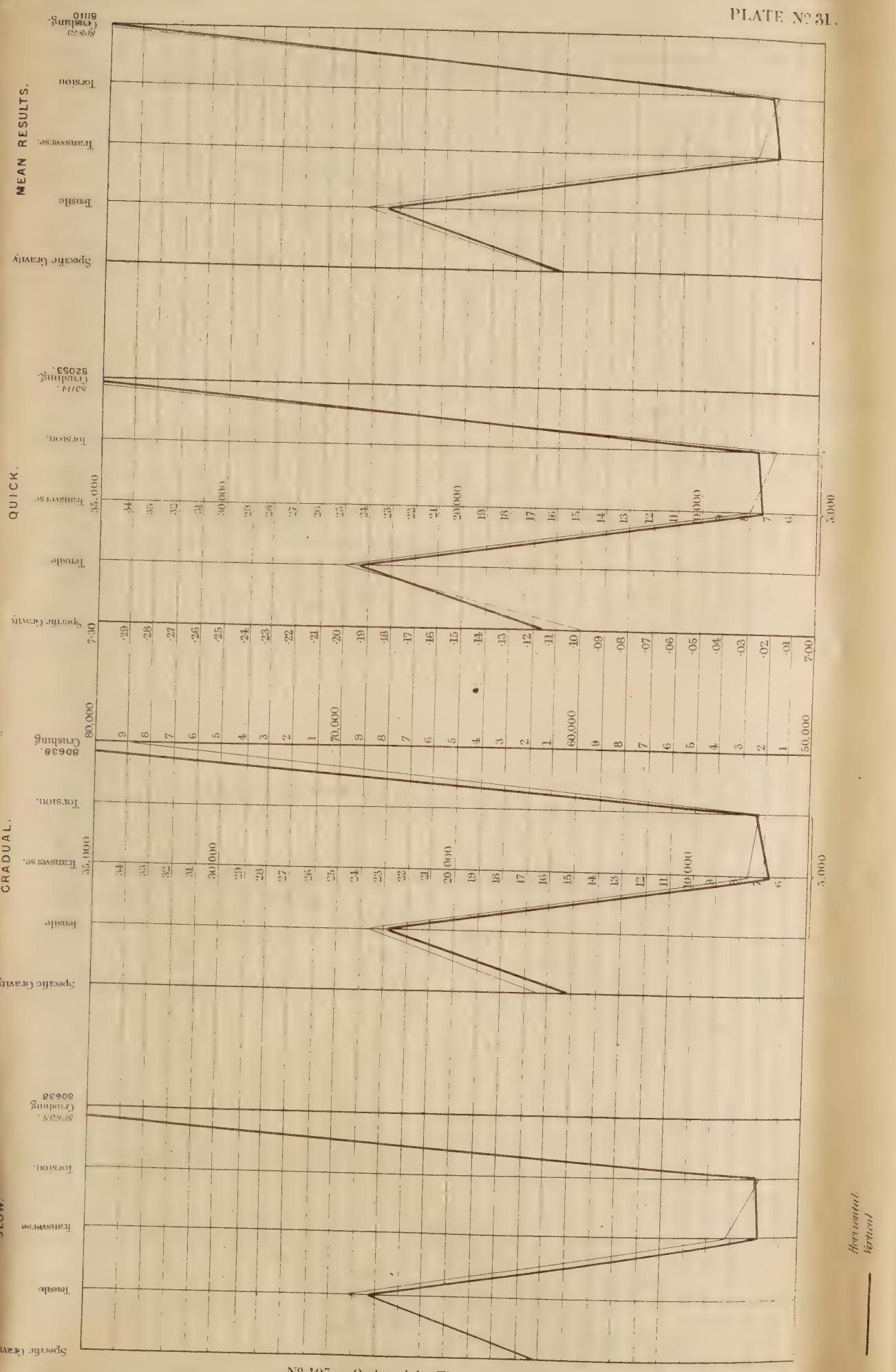
PLATE N° 30



N°497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith^rs to the Queen

Nº 7/2. Messrs Badger & Co Old Hill Furnaces, Near Dudley.



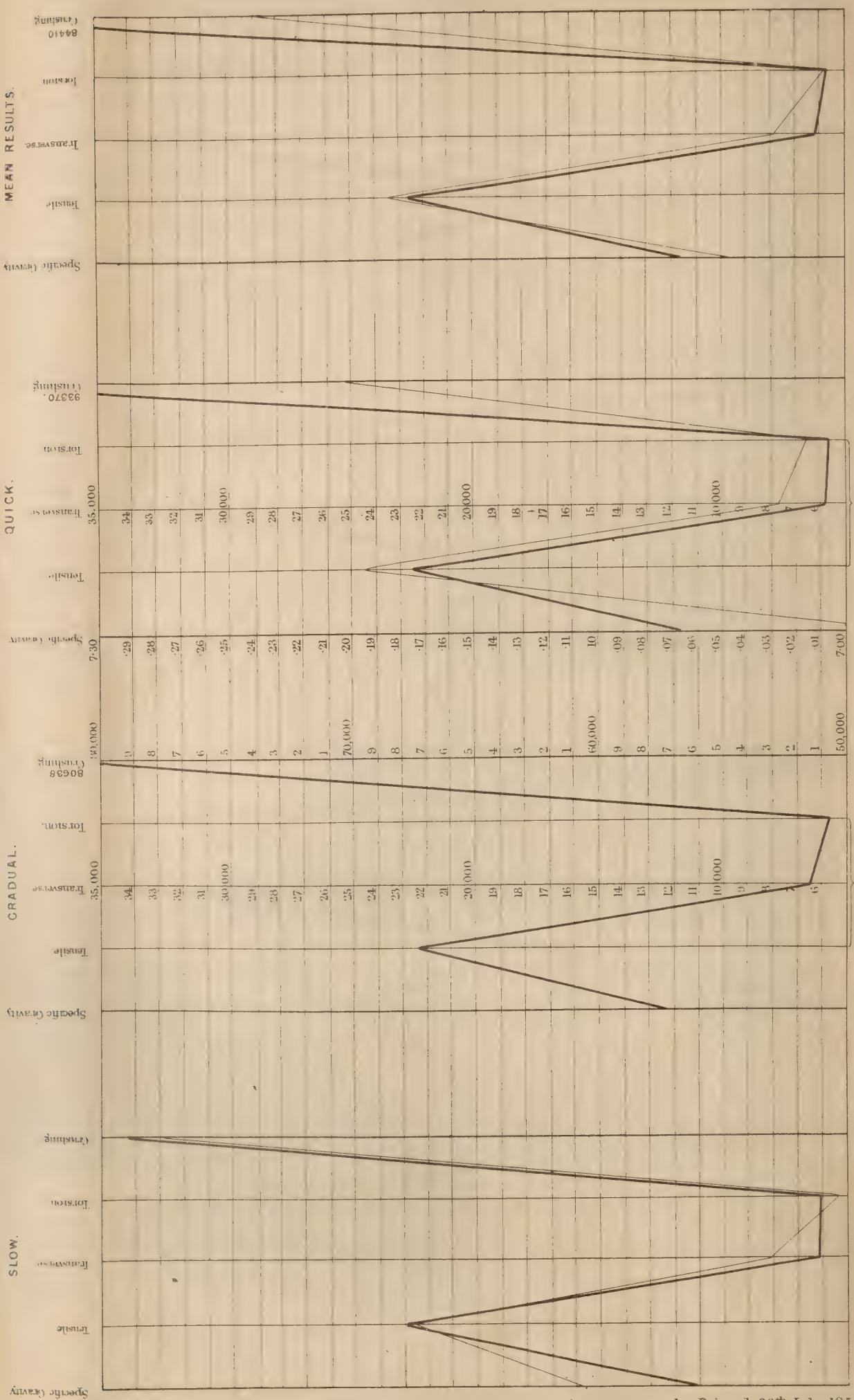
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1853.

Hall Bros. 1stho Castle St, Holborn

Henry Hu...

Nº 7/3 Messrs Badger & Co Old Hill Furnaces, Near Dudley.

PLATE Nº 32.



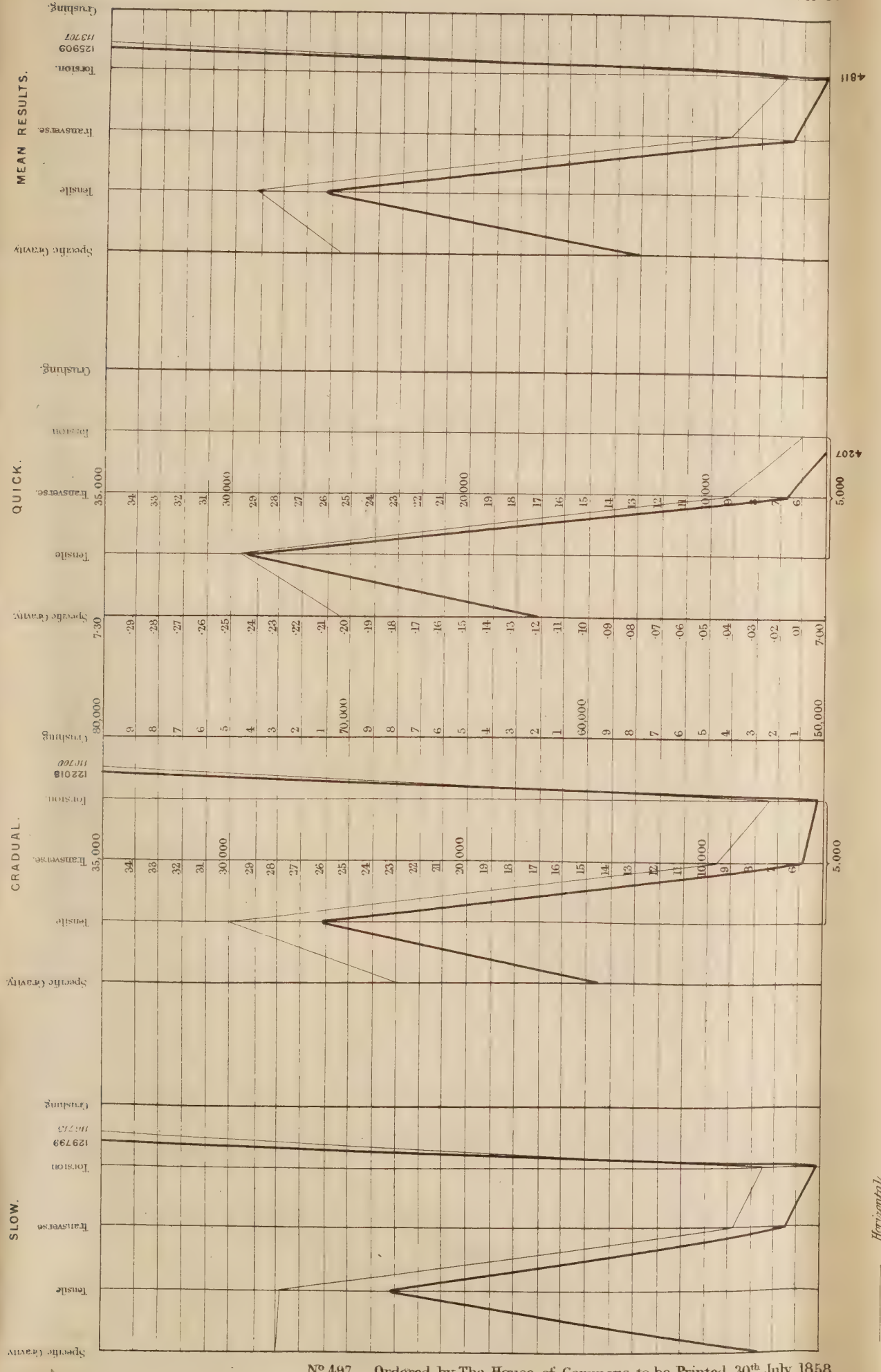
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bros. Lithe Castle St. Holborn

Henry Hansard,

No. 7. Messrs Badger & Co Old Hill Furnaces, near Dudley.

PLATE 33.



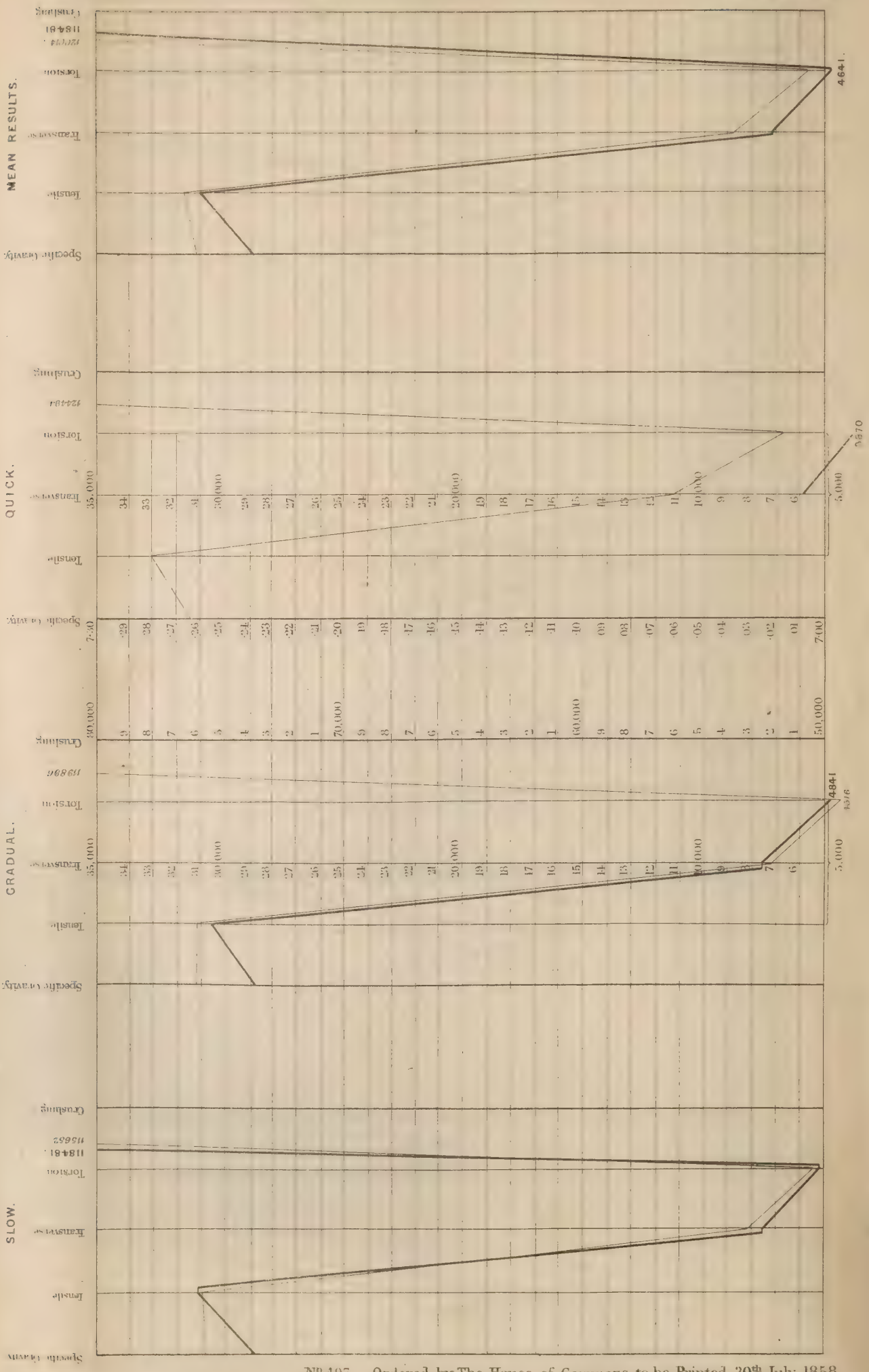
No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers Lithe Castle St. Holborn

Henry Hansard, Printer

No. 1. Messrs Firmstone, Lays Iron Works, Near Dudley.

PLATE No. 34.



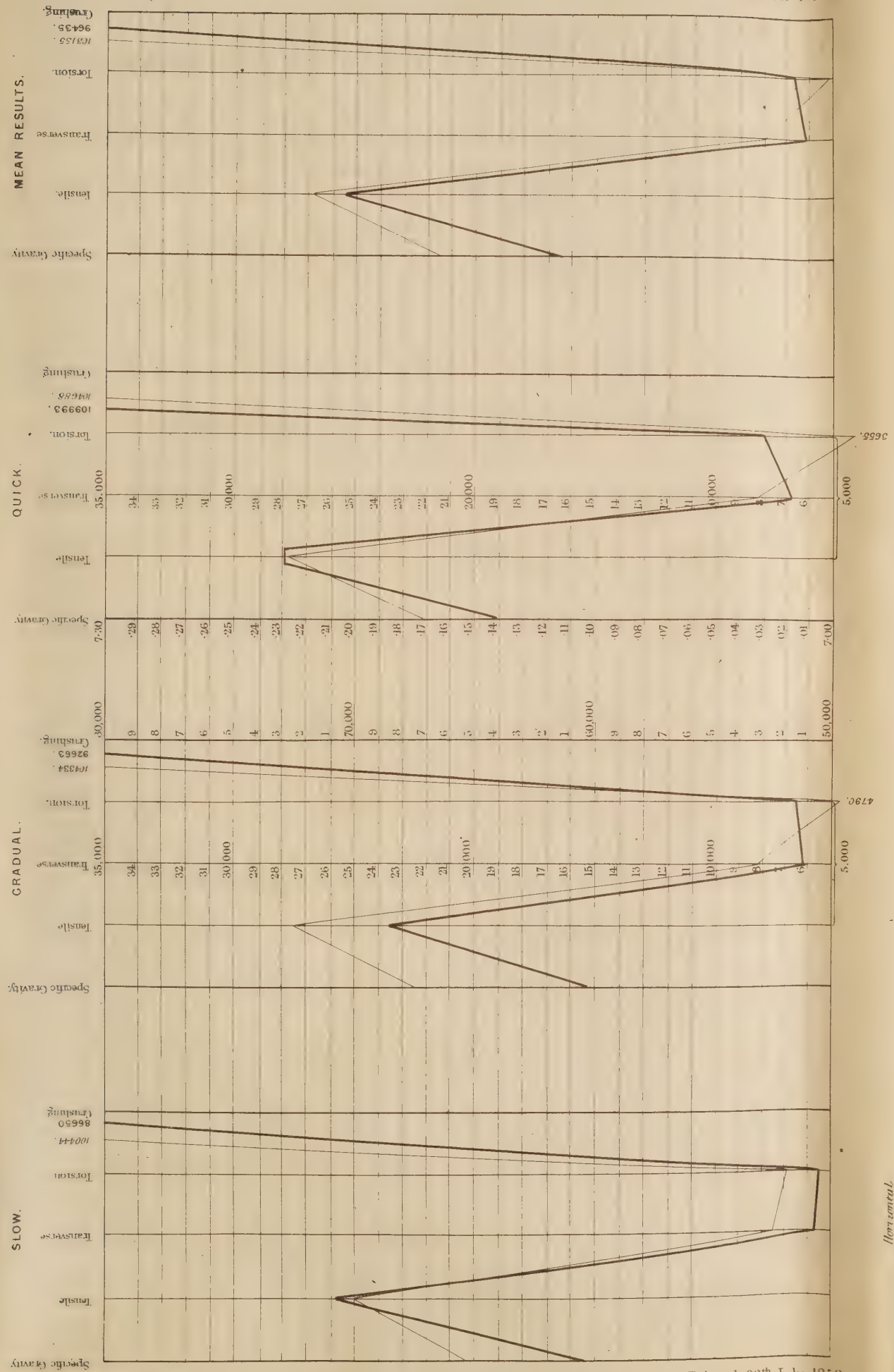
No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bros. Litho Castle St. Holborn

Henry Hansard, Printer

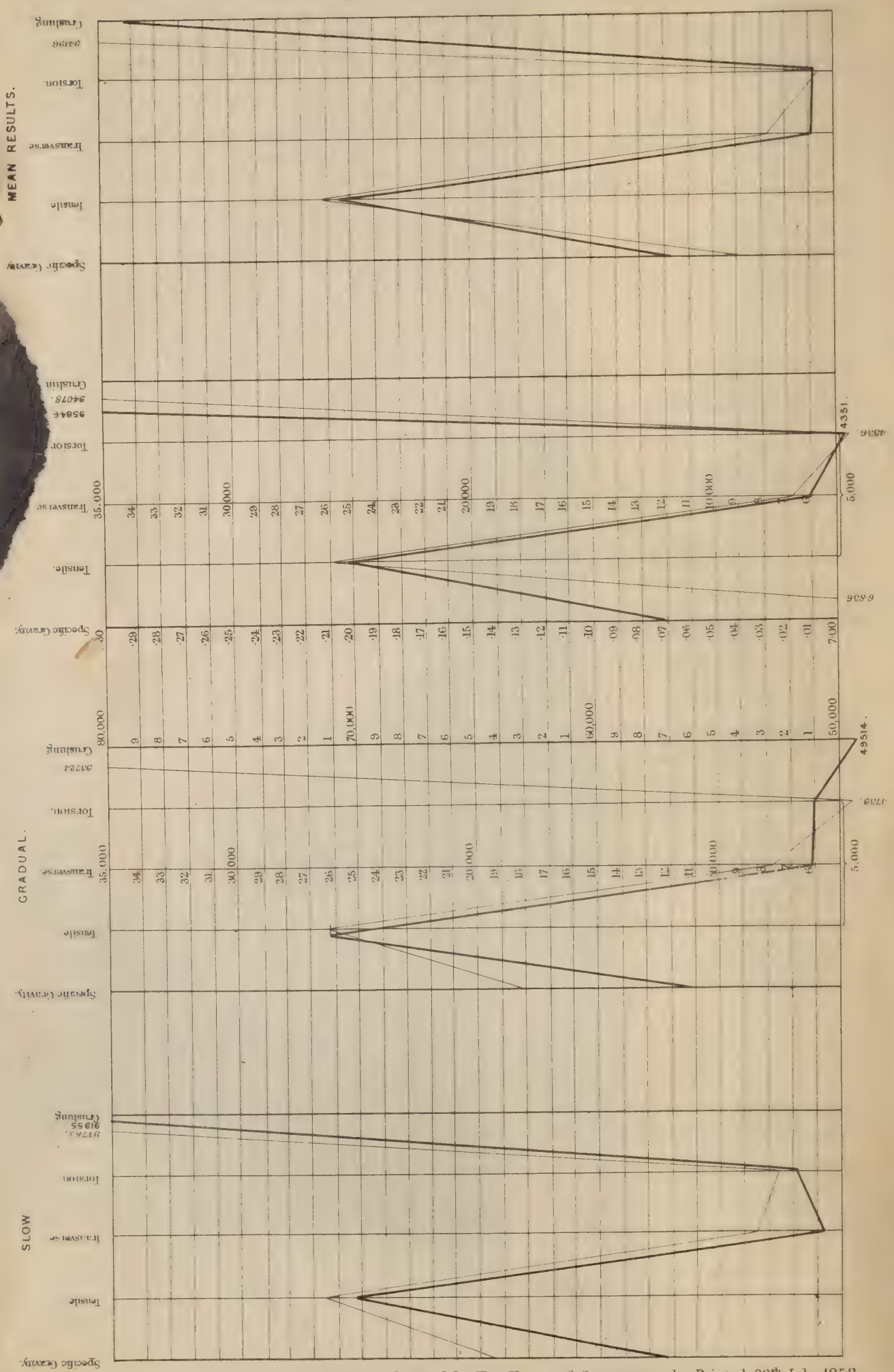
Lord Ward's Level Iron Works, Brierley Hill.

PLATE No. 35.



No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bro's Litho Castle St, Holborn.

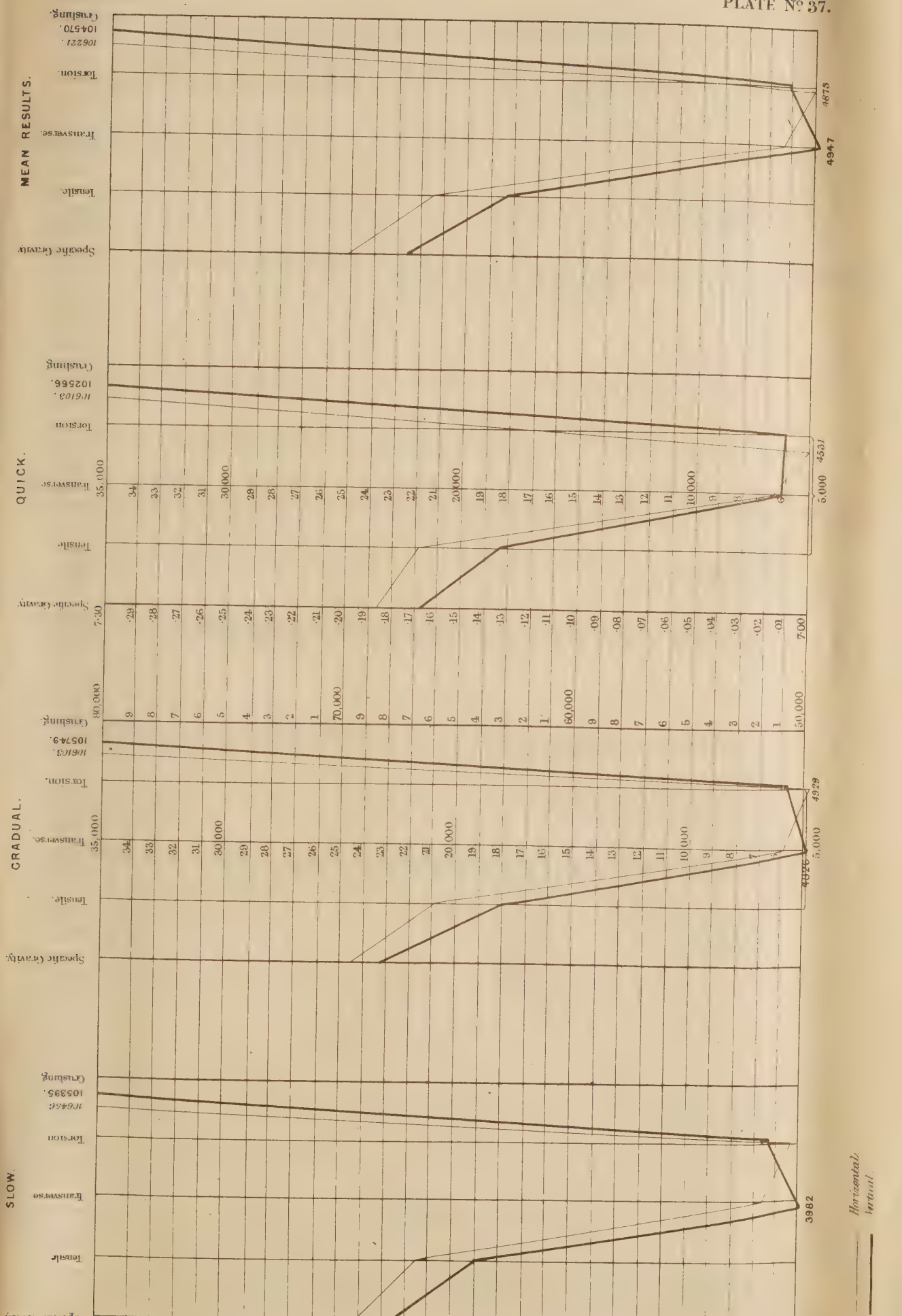


№ 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers Litho Castle St, Holborn

Henry Hansard, Printer

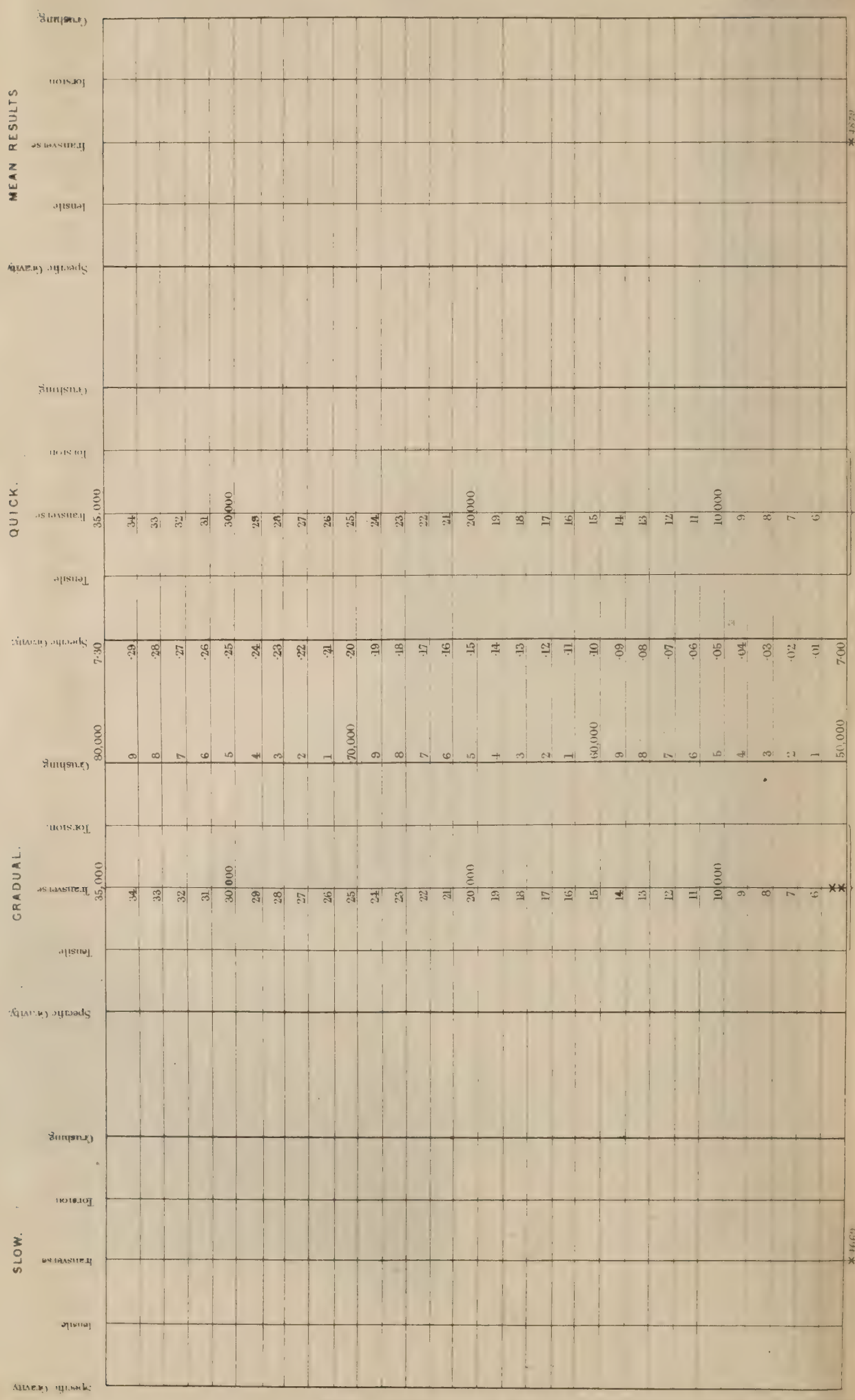
No. 9 1. Messrs Butlin & Co Wellingboro. Northamptonshire.



No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Kell. Bro's Lithe Castle St, Holborn

Henry Hansard, Printer.



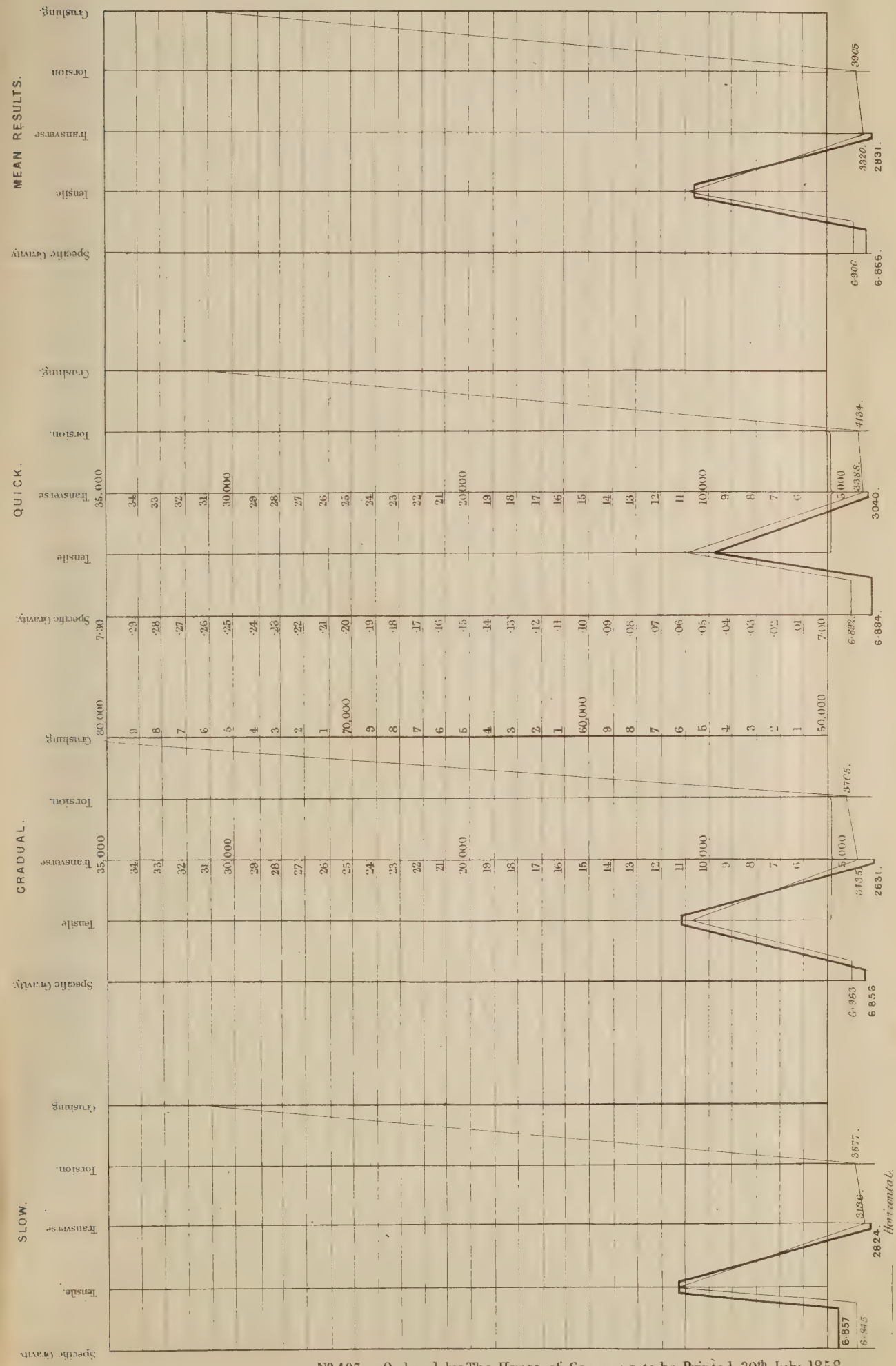
№ 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers Litho Castle St. Holborn.

Henry Hansard, Printer.

Nº 18/1. Messrs Judkins, Heyford Iron Works, near Weedon.

PLATE Nº 39.



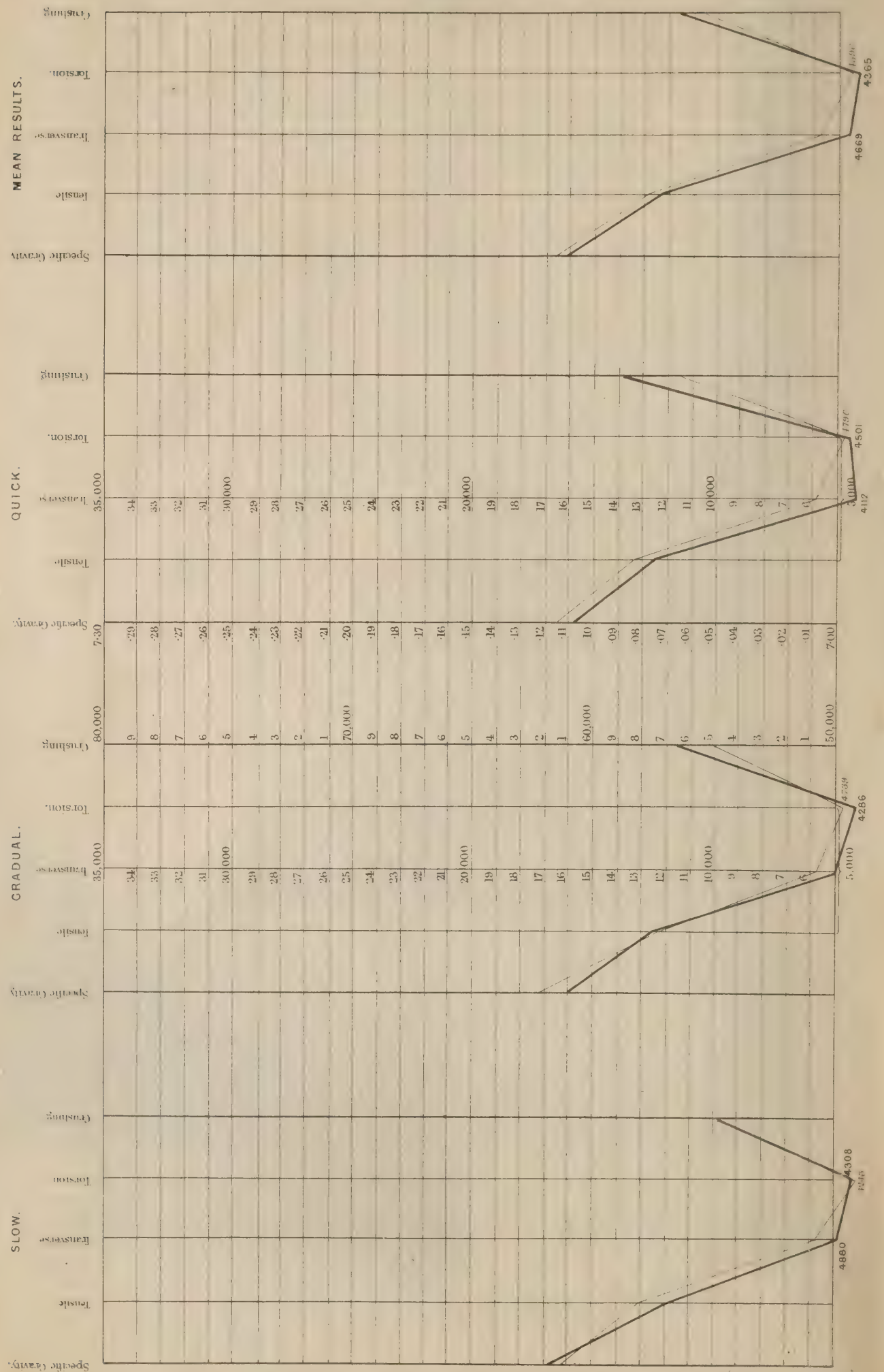
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Kell Bros. Litho Castle St. Holborn.

Henry Hansard, Printer.

Nº 4. The Forest of Dean Compy Park End Iron Works, Gloucestershire.

PLATE Nº 40.



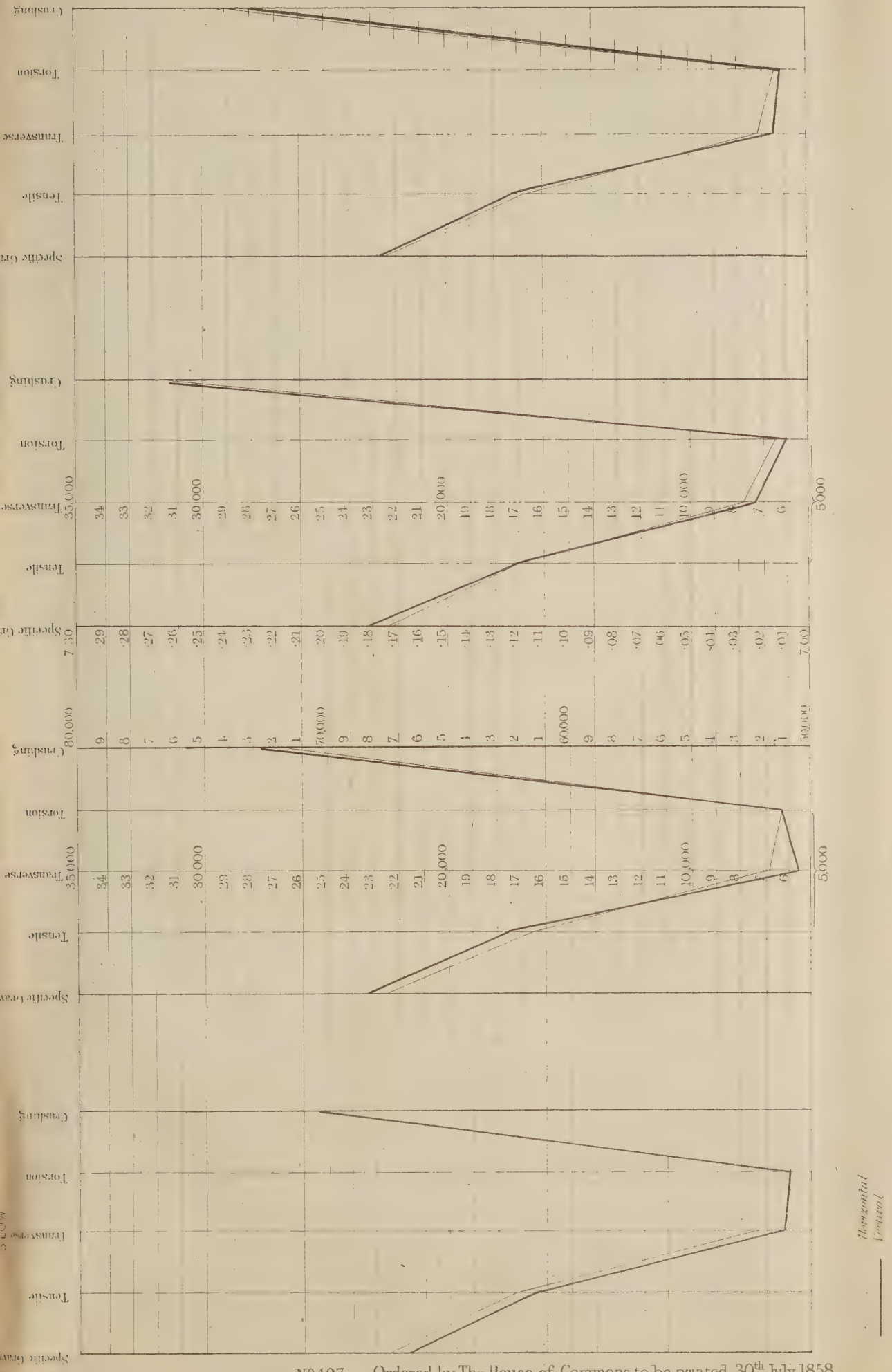
Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bros. Litho Castle St. Holborn

Henry Hansard,

N° 4/2 FOREST OF DEAN COMP^Y PARK END IRON WORKS NEAR LYDNEY GLOUCESTERSHIRE.

PLATE N° 41.



Horizontal
Vertical

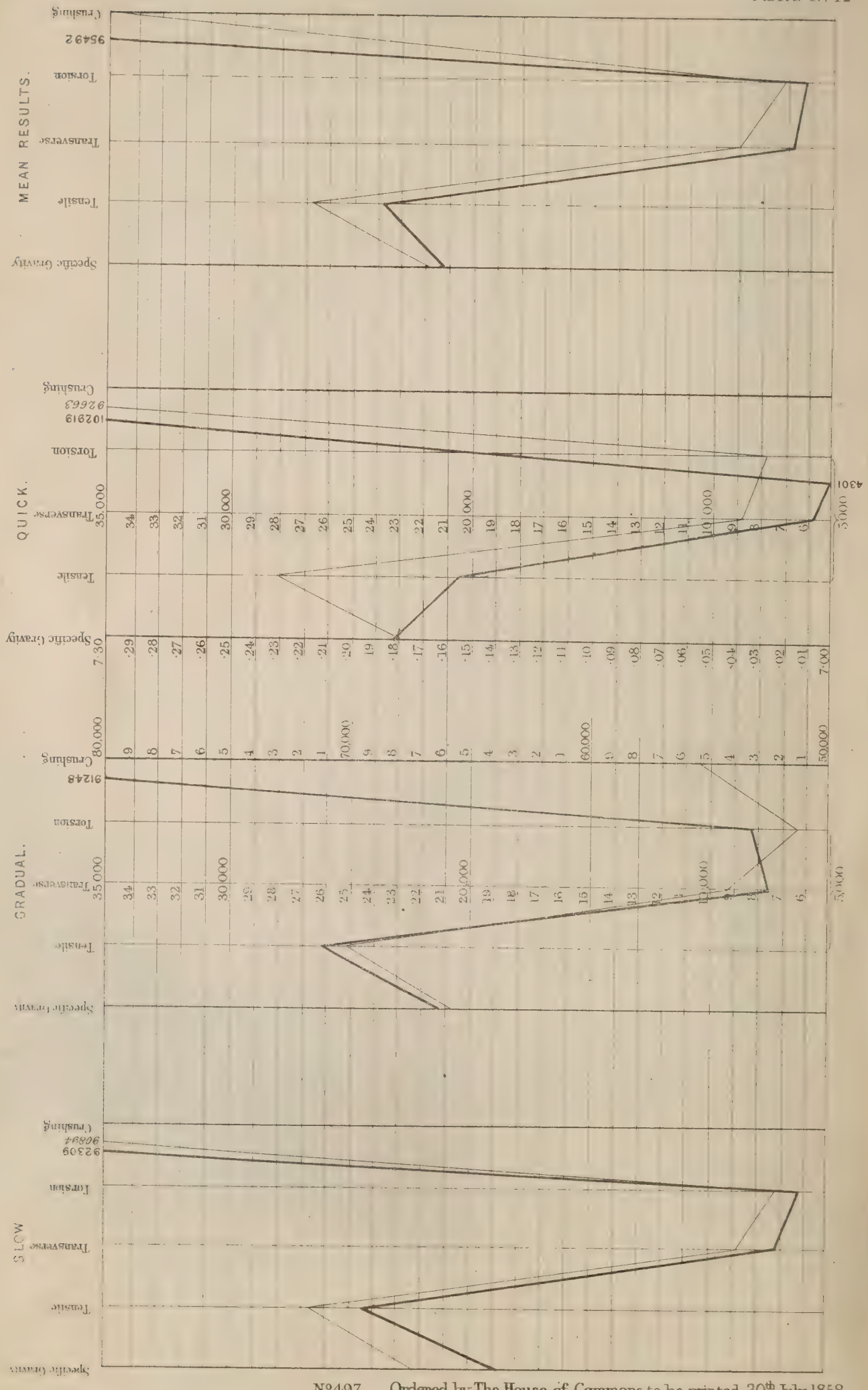
N°497. Ordered by The House of Commons to be printed, 30th July, 1858.

Dav & Son Lith to the Queen

Henry Hansard, Printer

No 1 MESSRS PALMER & BUDD, YSTALYFERA IRON WORKS, SWANSEA.

PLATE No. 42

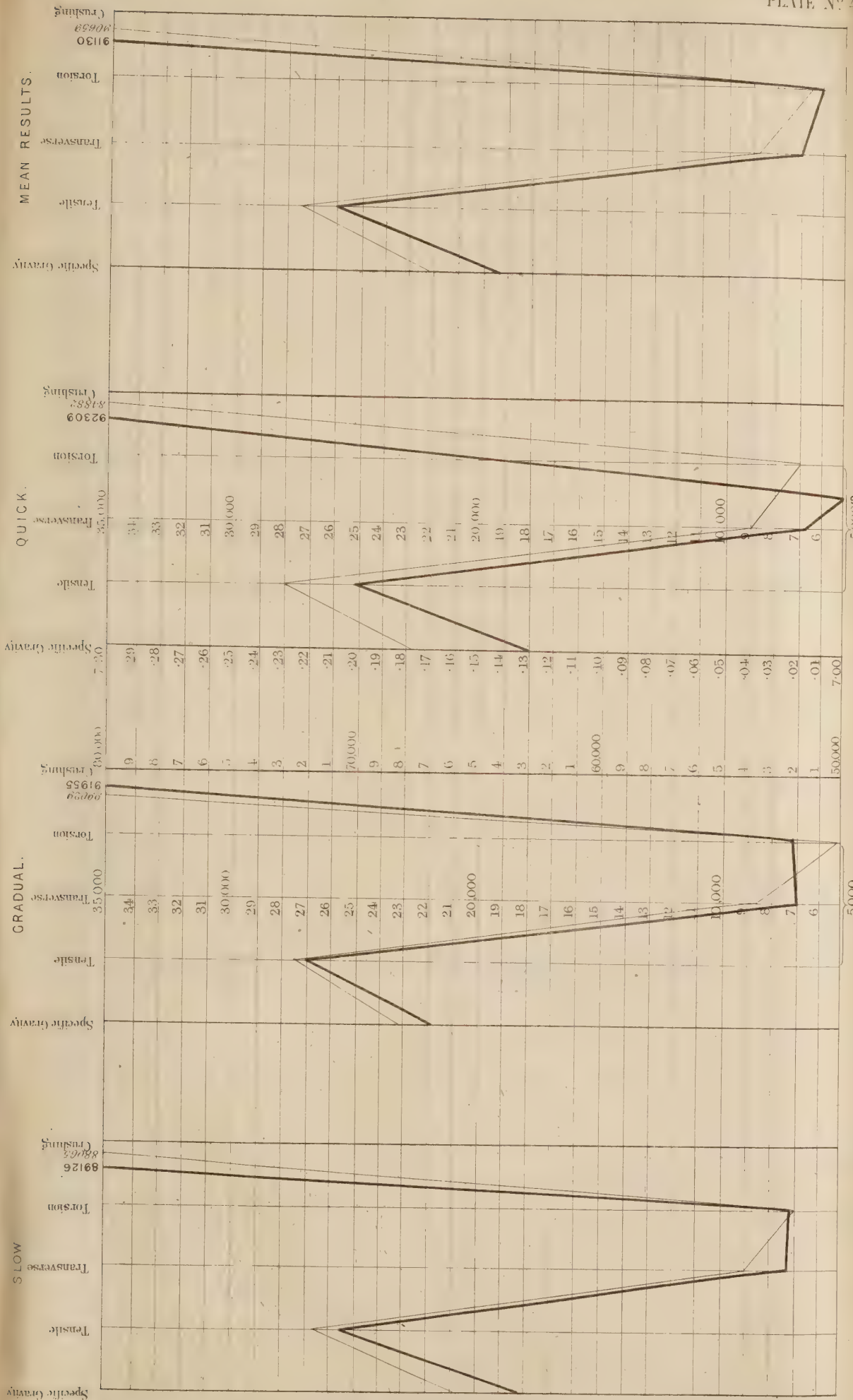


No 497. Ordered by The House of Commons to be printed, 30th July, 1858.

Horizontal
Vertical

No 2 MESSRS PALMER & BUDD, YSTALYFERA IRON WORKS, SWANSEA.

PLATE No 43

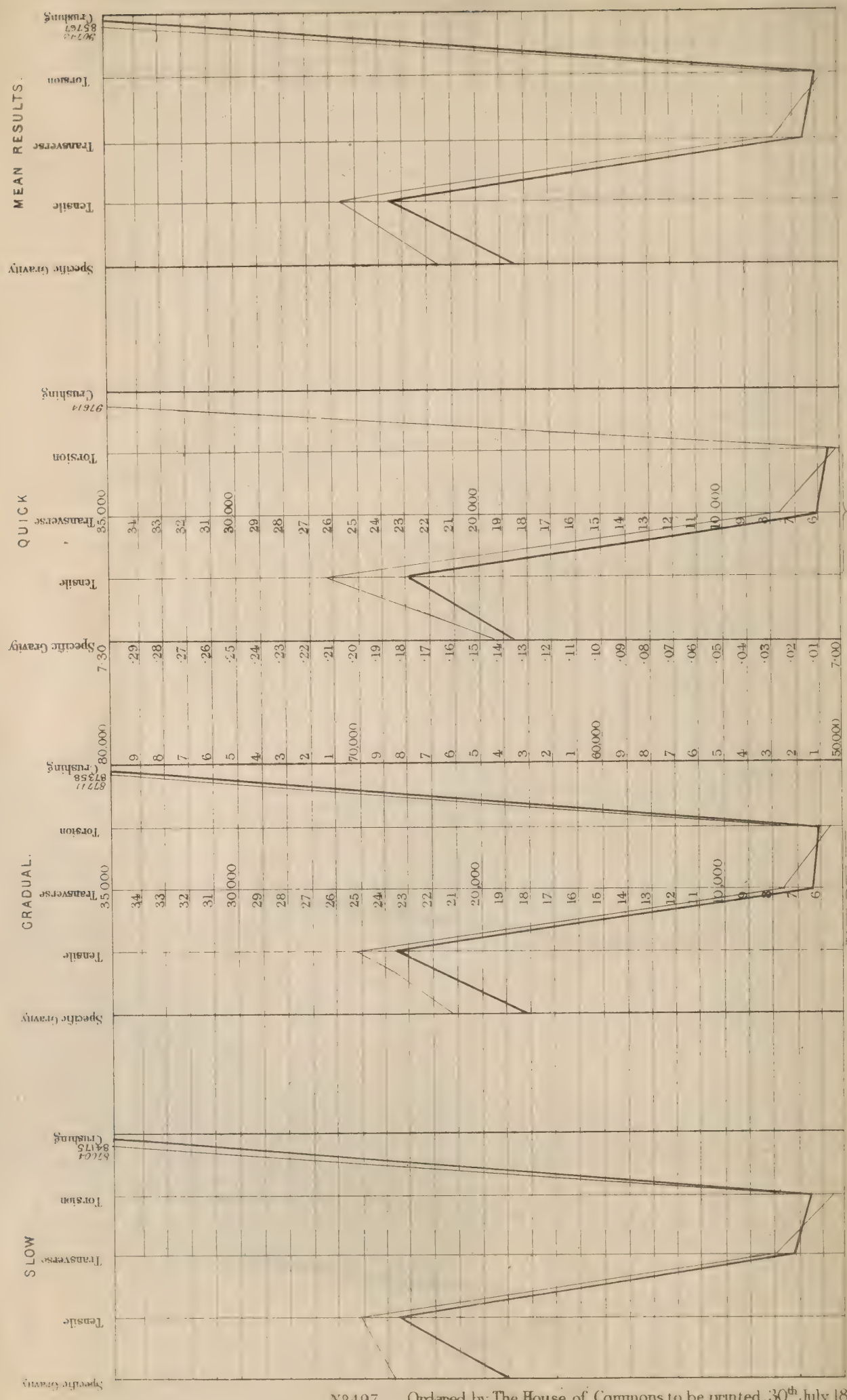


No 497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith.rs to the Queen. Henry Hansard Printer

No 3/4 MESSRS PALMER & BUDD, YSTALYFERA IRON WORKS, SWANSEA.

PLATE No 44.

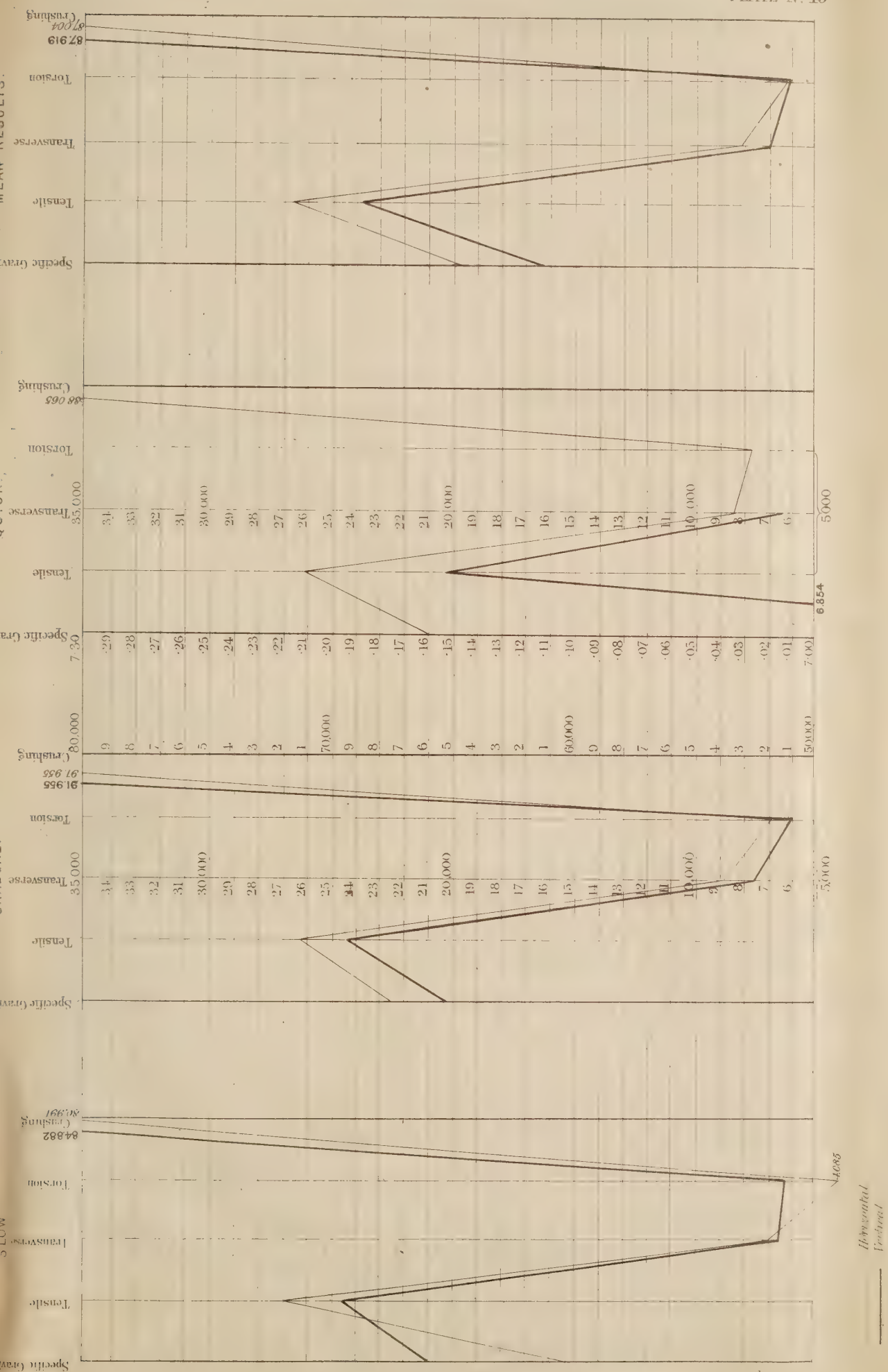


No 497. Ordered by The House of Commons to be printed, 30th July, 1858.

Vincent Brooks Day & Son Lith. to the House.

No ¾ MESSRS PALMER & BUDD, YSTALYFERA IRON WORKS, SWANSEA.

PLATE No. 45



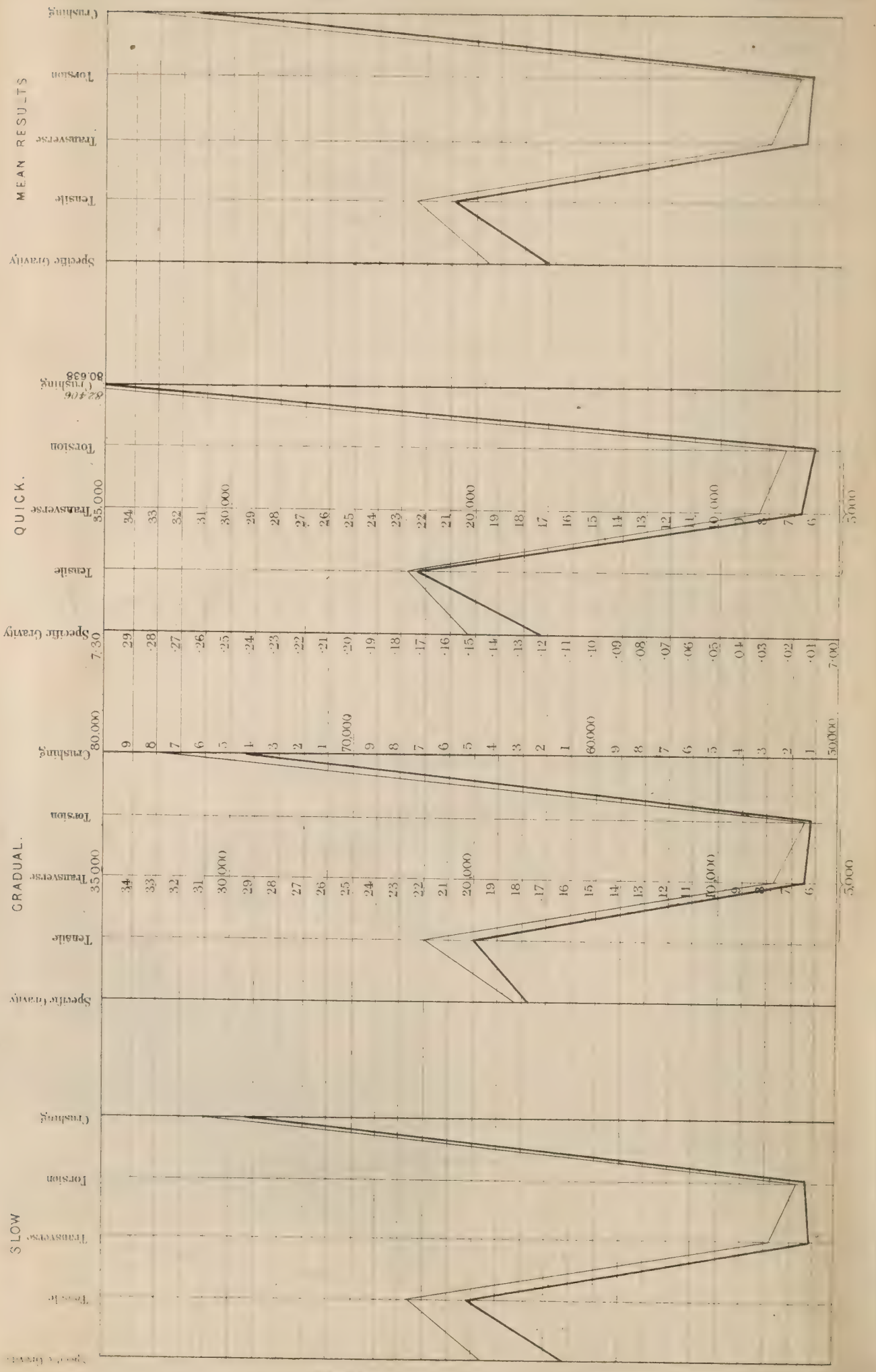
No. 497. Ordered by The House of Commons to be printed, 30th. July. 1858.

Day & Son Lith.rs to the Queen

Henry Hall

No $\frac{3}{5}$ MESSRS PALMER & BUDD, YSTALYFERA IRON WORKS, SWANSEA.

PLATE N° 46

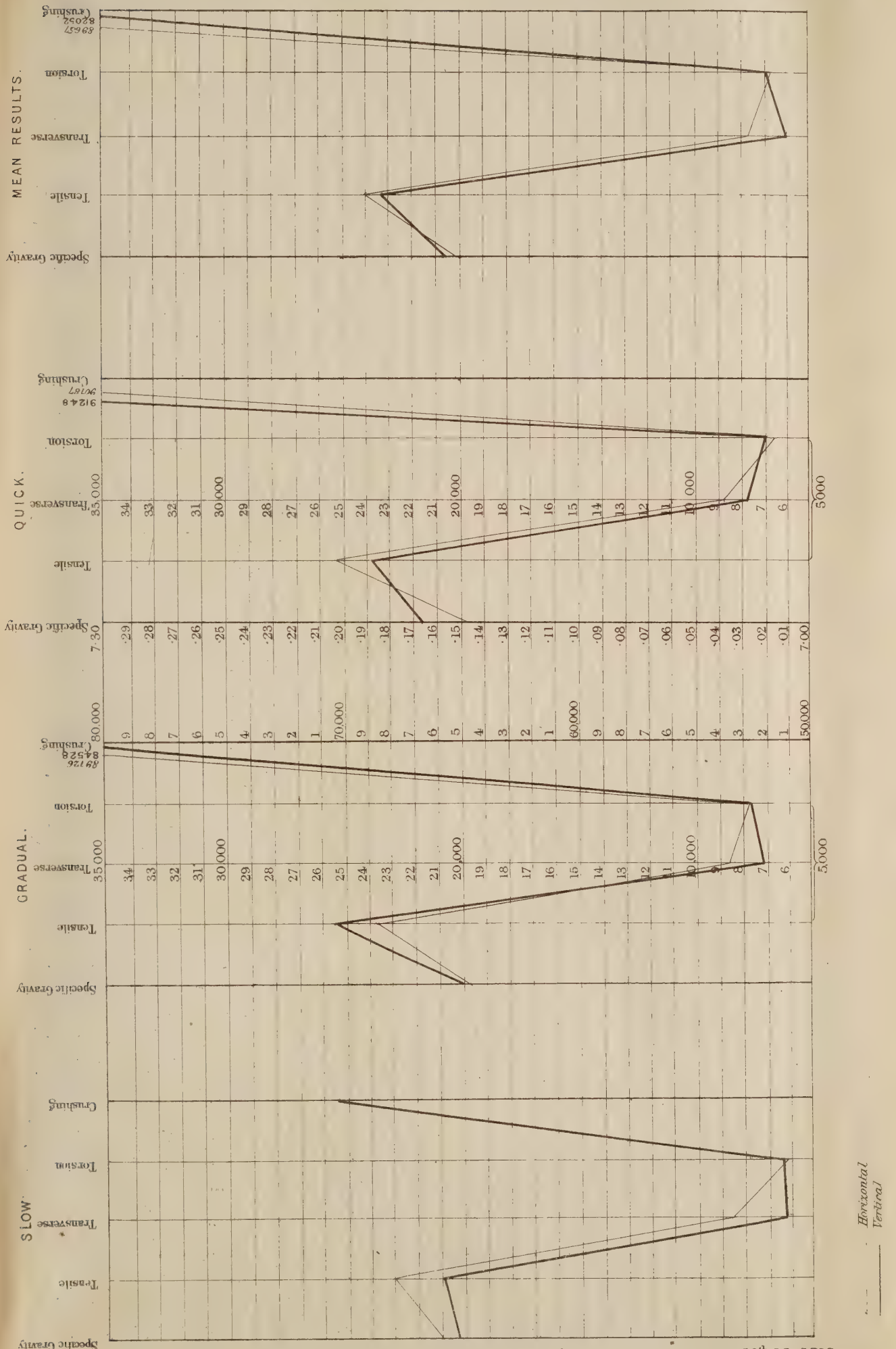


N°497. Ordered by The House of Commons to be printed, 30th July, 1858.

Henry Hansard.

No 3 Messrs Palmer & Budd, Ystalyfera Iron Works, Swansea.

PLATE No 47.



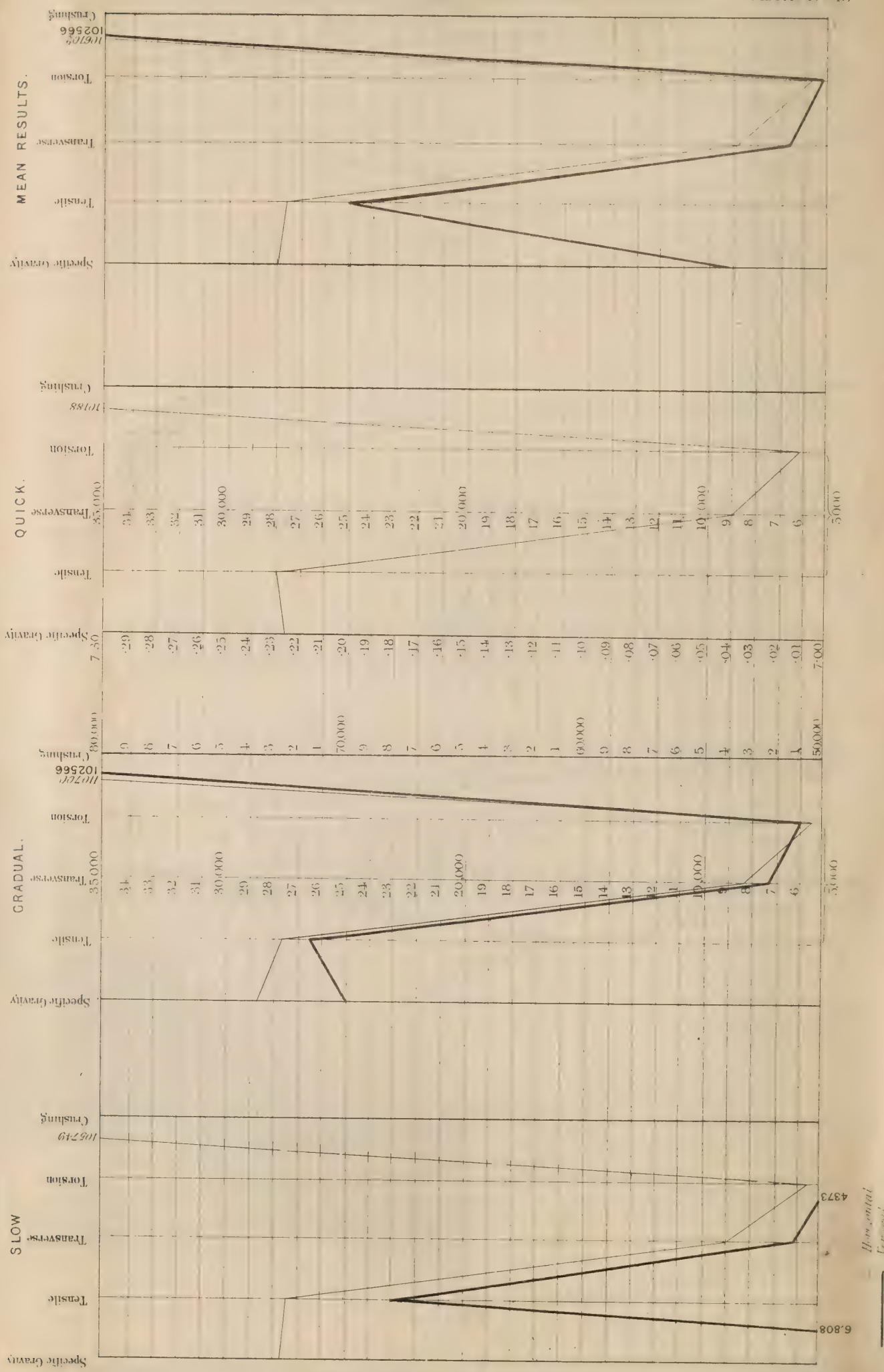
No 497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith.rs to the Queen.

Henry Hansard, Printer.

N°$\frac{14}{1}$ MESSRS THOMAS, BLAENAVON IRON WORKS MONMOUTHSHIRE . .

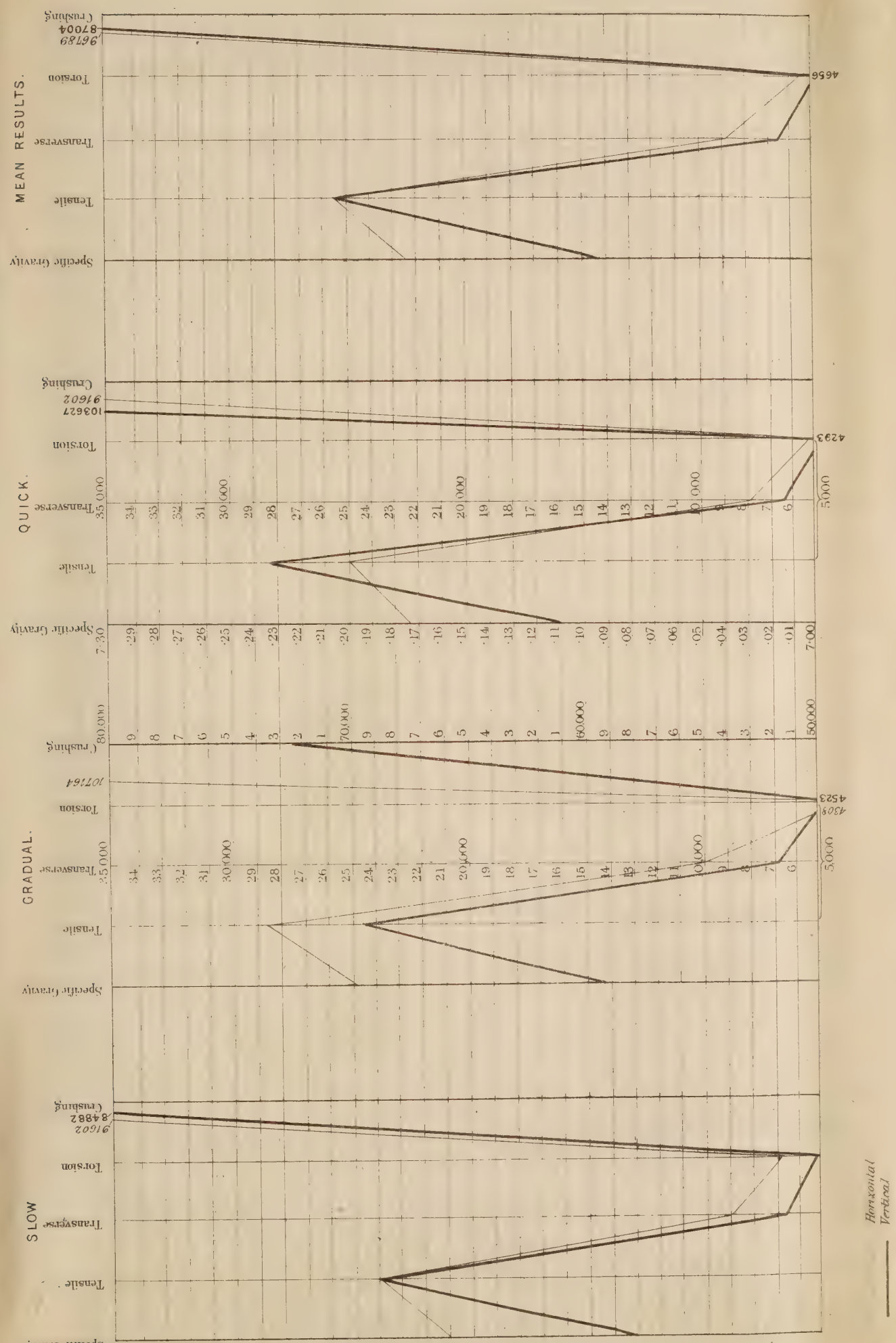
PLATE N° 48



N°497. Ordered by The House of Commons to be printed, 30th July, 1858.

N° 14/2 Messrs Thomas, Blaenavon Iron Works Monmouthshire

PLATE N° 49



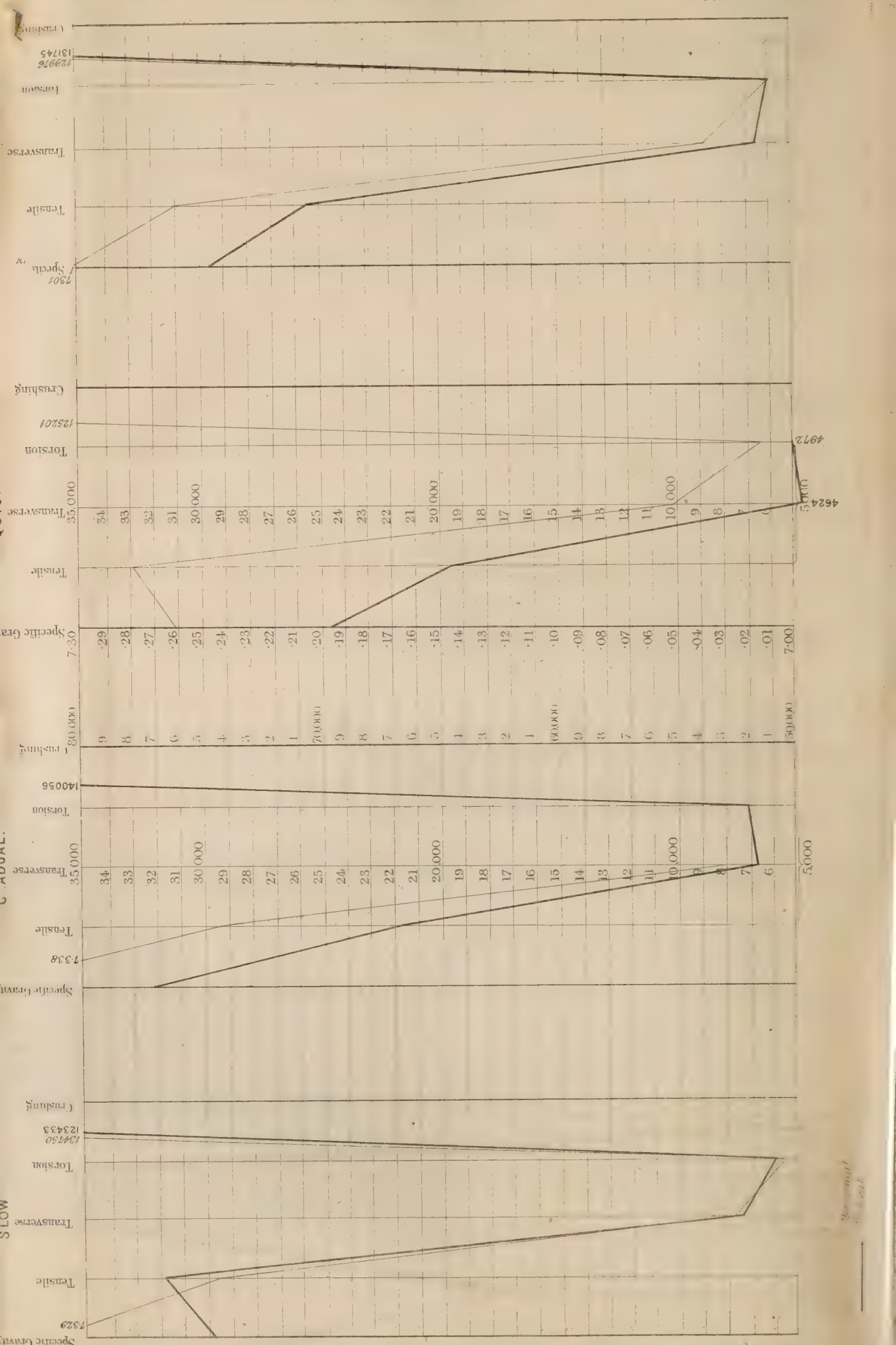
N° 497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith.rs to the Queen

Henry Hansard Printer

N° 14/3 MESSRS THOMAS. BLAENAVON IRON WORKS MONMOUTHSHIRE

PLATE N° 50



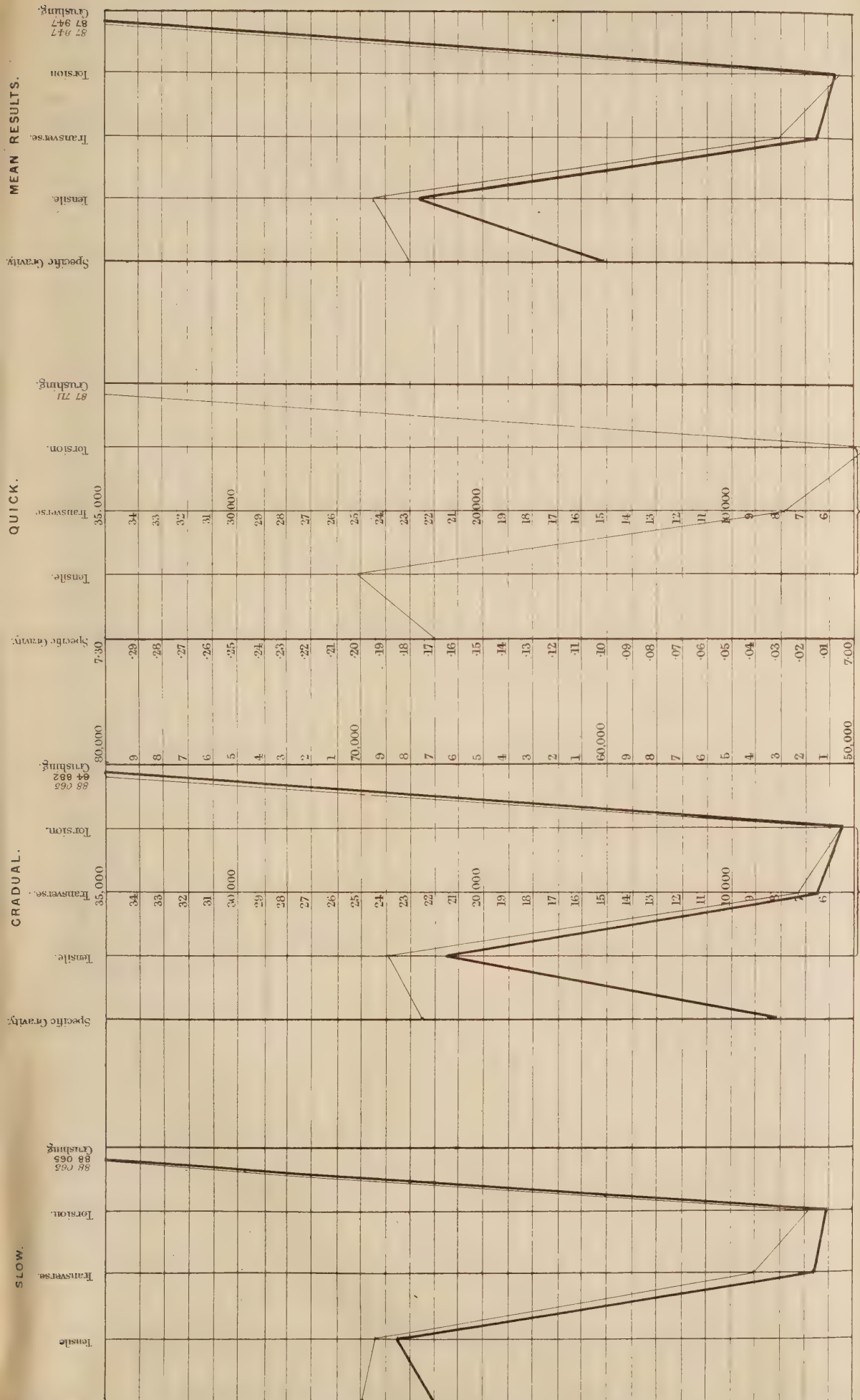
N°497. Ordered by The House of Commons to be printed, 30th July, 1858.

Day & Son Lith.rs to the Queen

Henry Hansard,

Nº 14/4. Messrs Thomas, Blaenavon Iron Works.

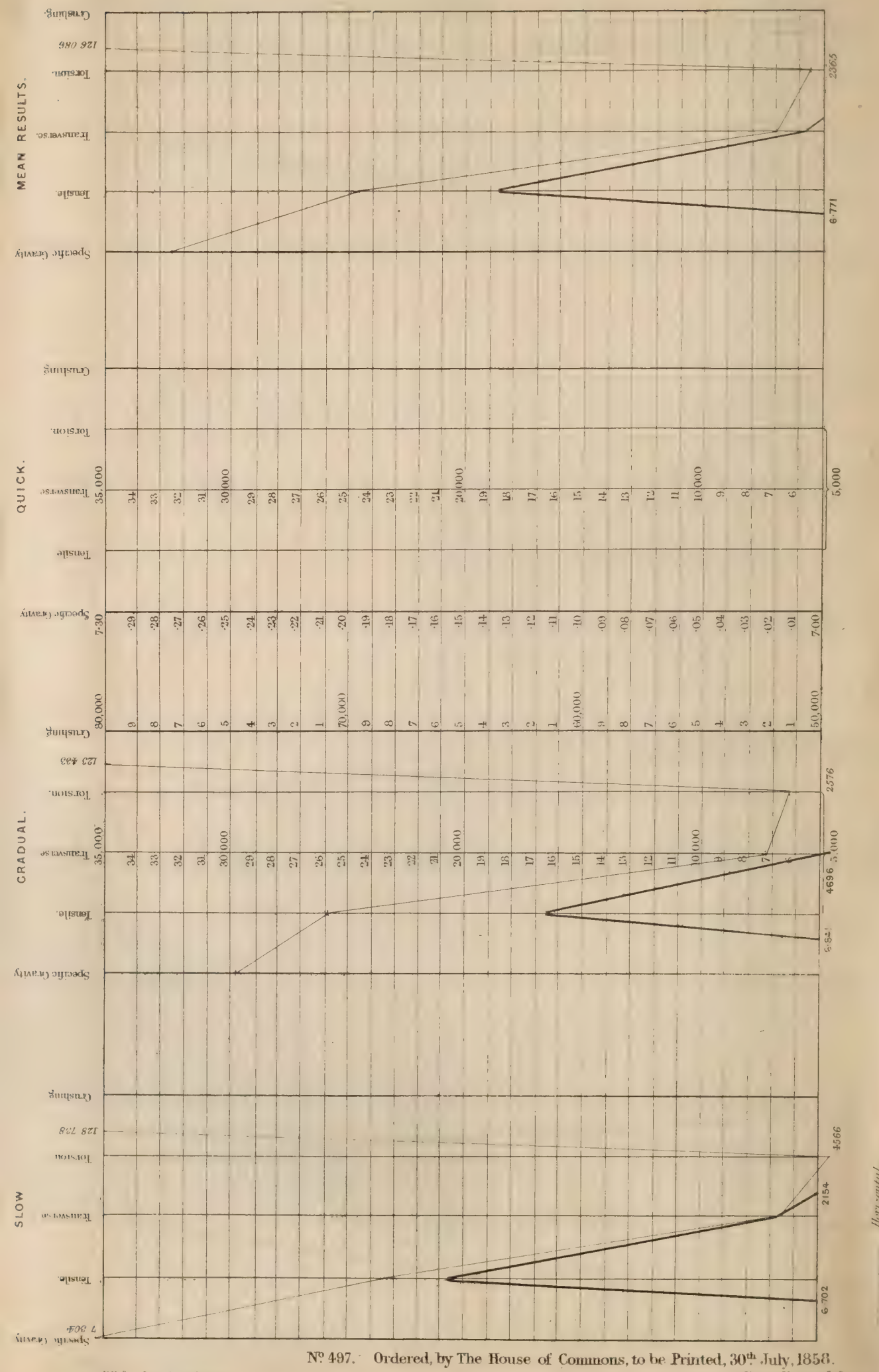
PLATE Nº 51.



Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers Litho. Castle St, Holborn

Henry Hansard, Printer.



No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

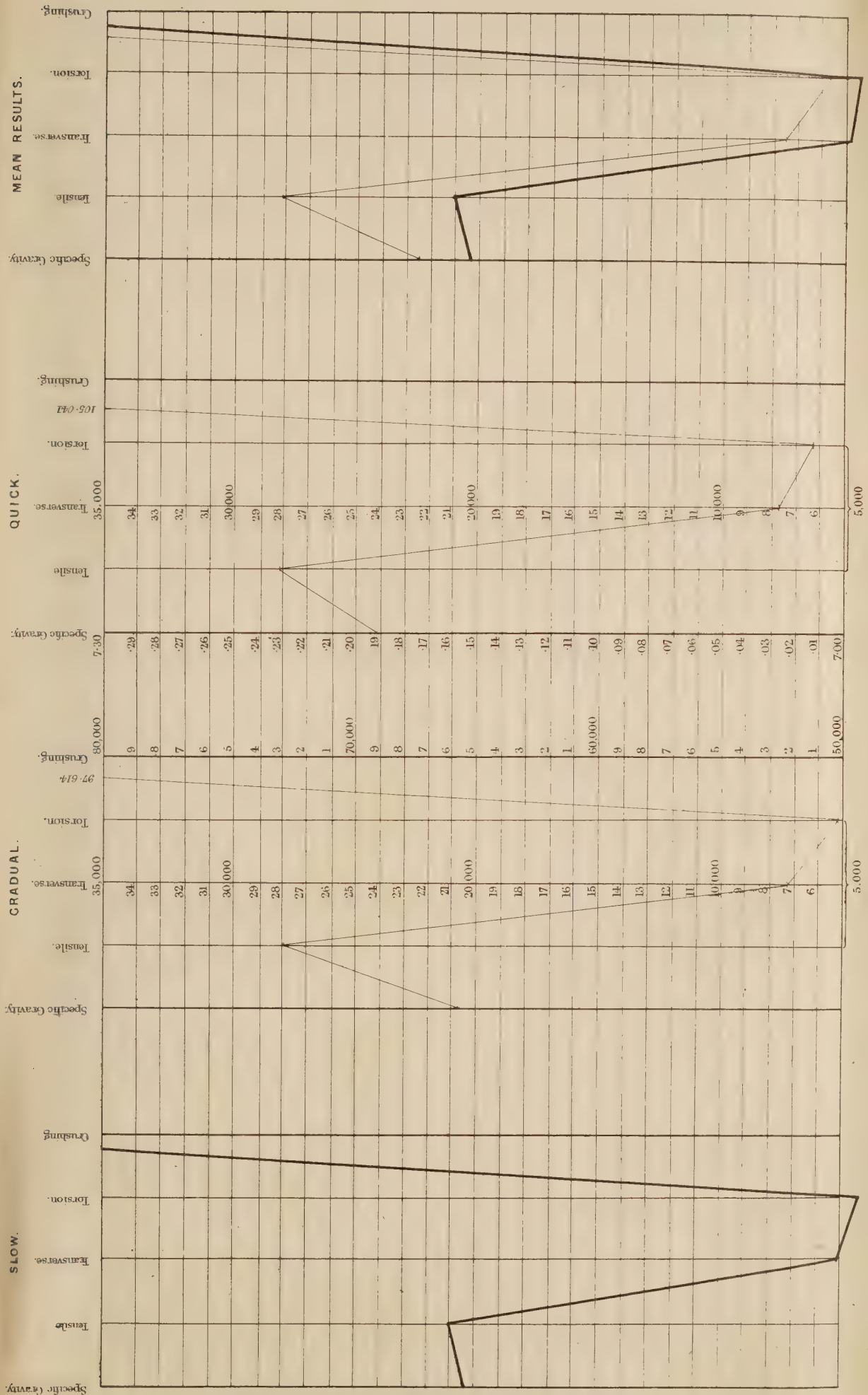
Hall Brothers Litho Castle St, Holborn

Henry Hansard, Printer

No. 13 1.

Messrs Firmstone, Pontypool Iron Works.

PLATE No. 53.



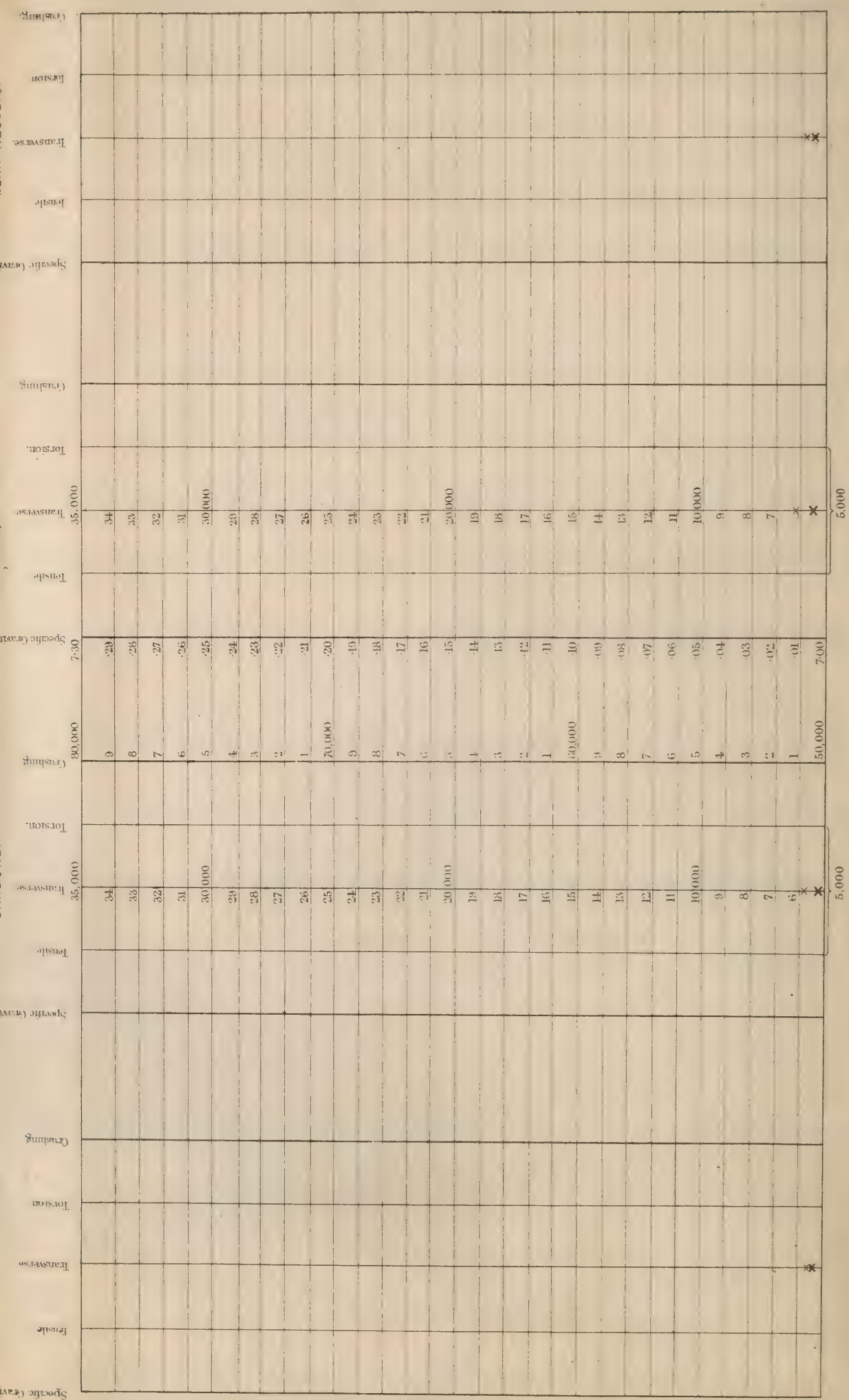
No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers, Litho Castle St, Holborn

Henry Hansard, Printer.

Messrs Begbie. Swedish Grey Iron.

PLATE № 54.



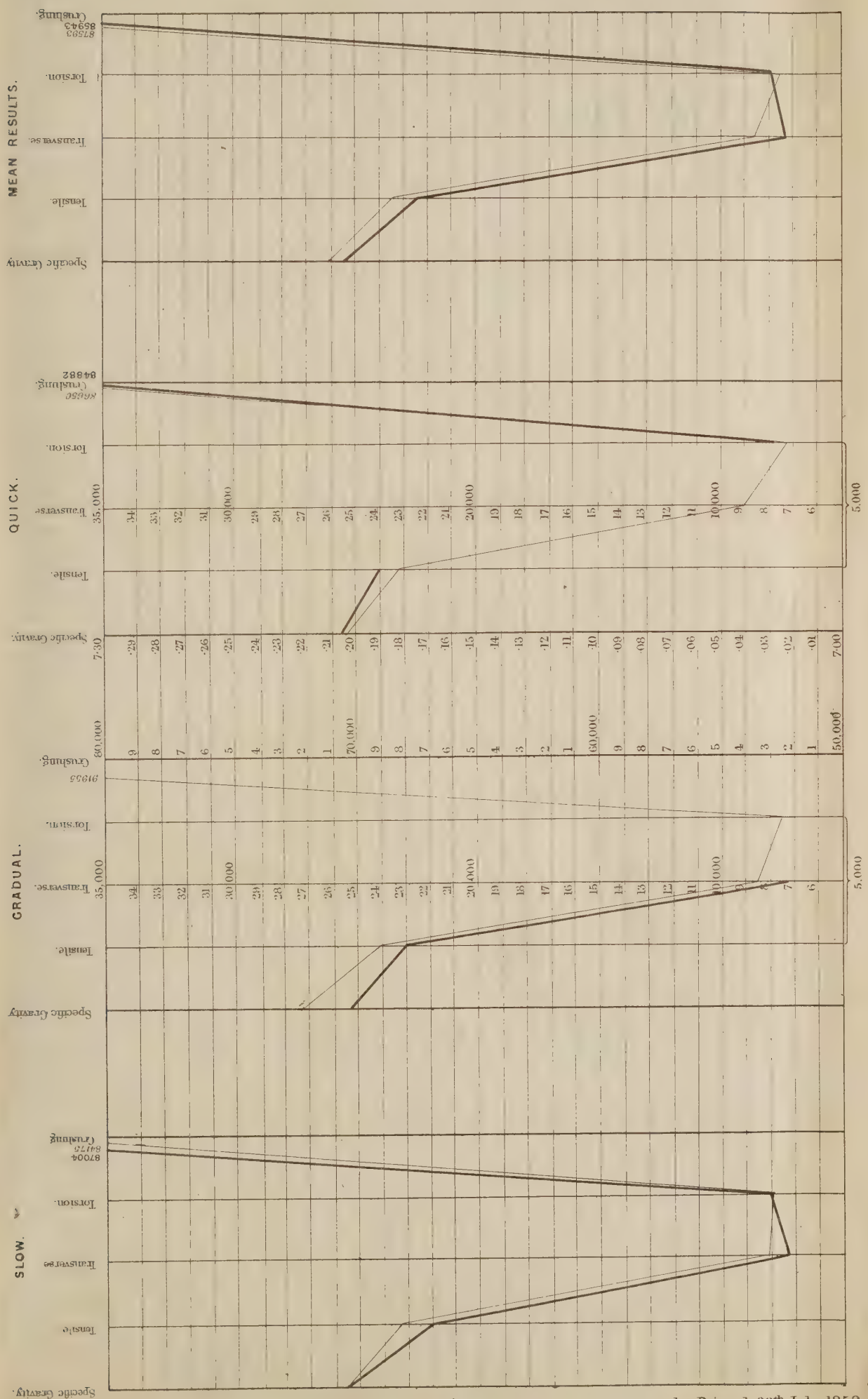
№ 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Bros. Litho Castle St, Holborn

Henry Hansard & Son Printers

Nº $\frac{23}{1}$ Messrs Sweetland, Acadian Charcoal Iron Compy

PLATE Nº 55.

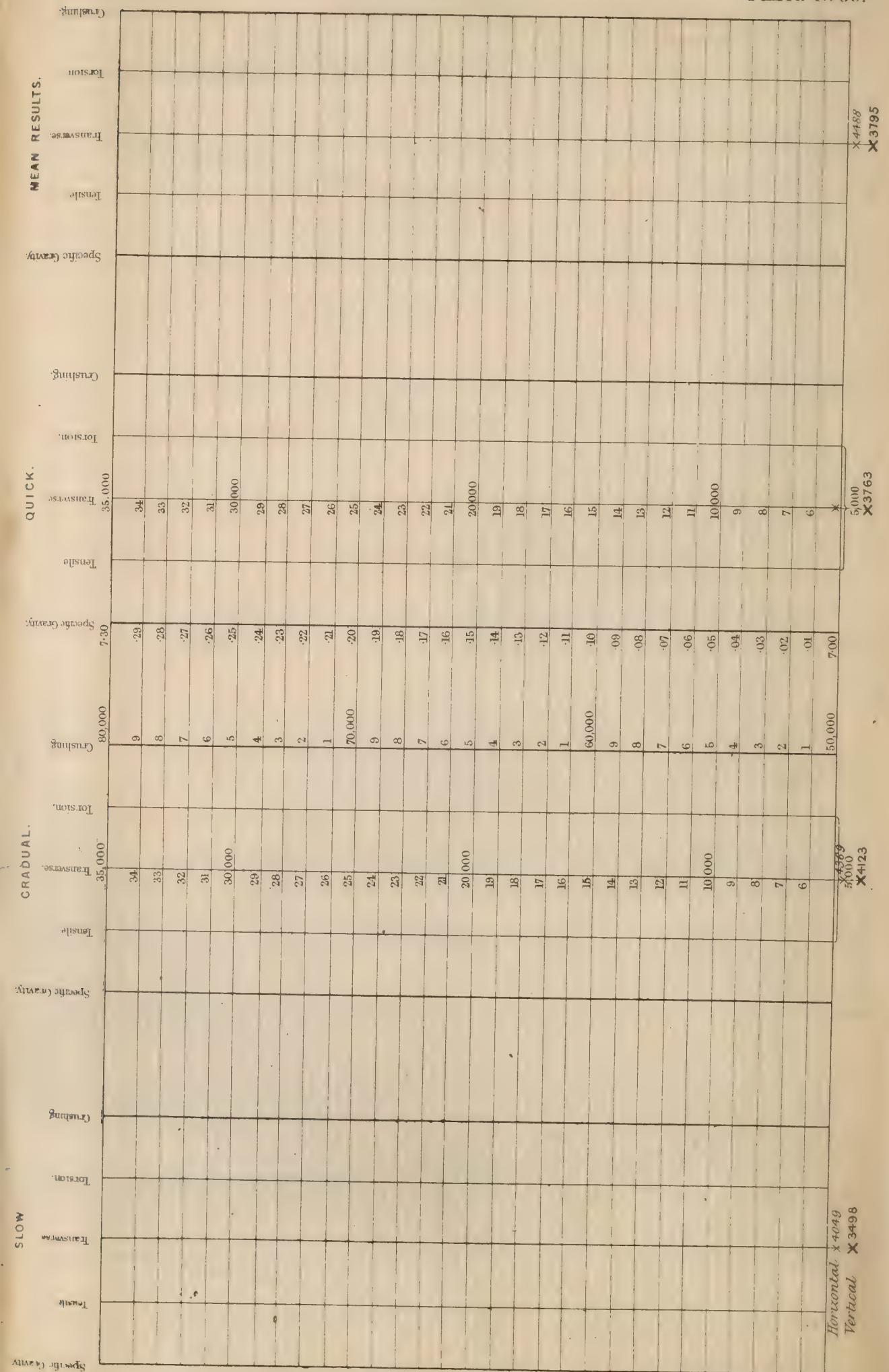


Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Henry Hansard, Printer.

Nº 23/2 Messrs Sweetland, Acadian Charcoal Iron Compy

PLATE Nº 56.

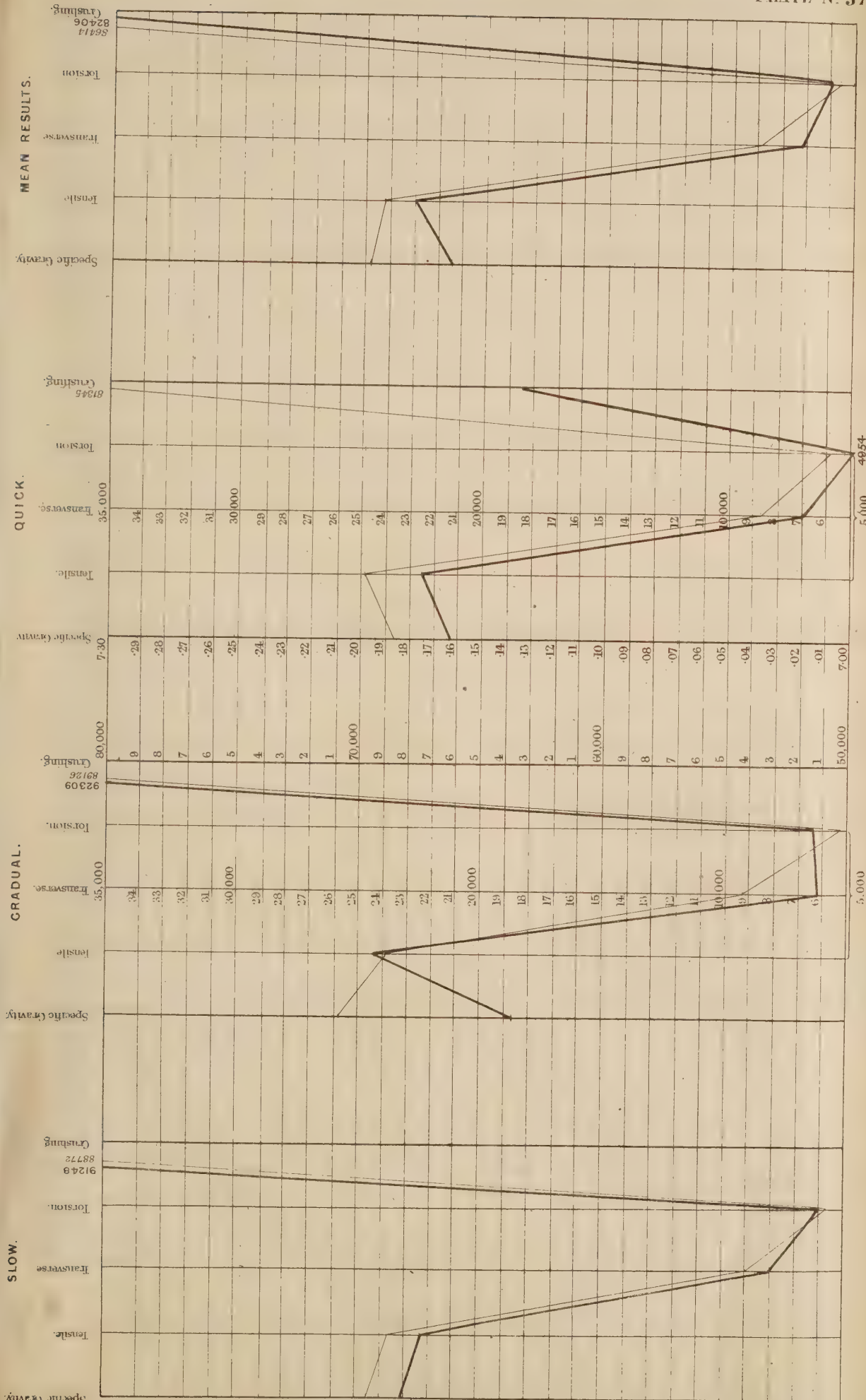


Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Hall Brothers, Lithe Castle St. Holborn

Henry Hansard, Printer

No. 21/1. MESSRS TOWNSEND, NEW YORK. "STERLING PIG IRON".



No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

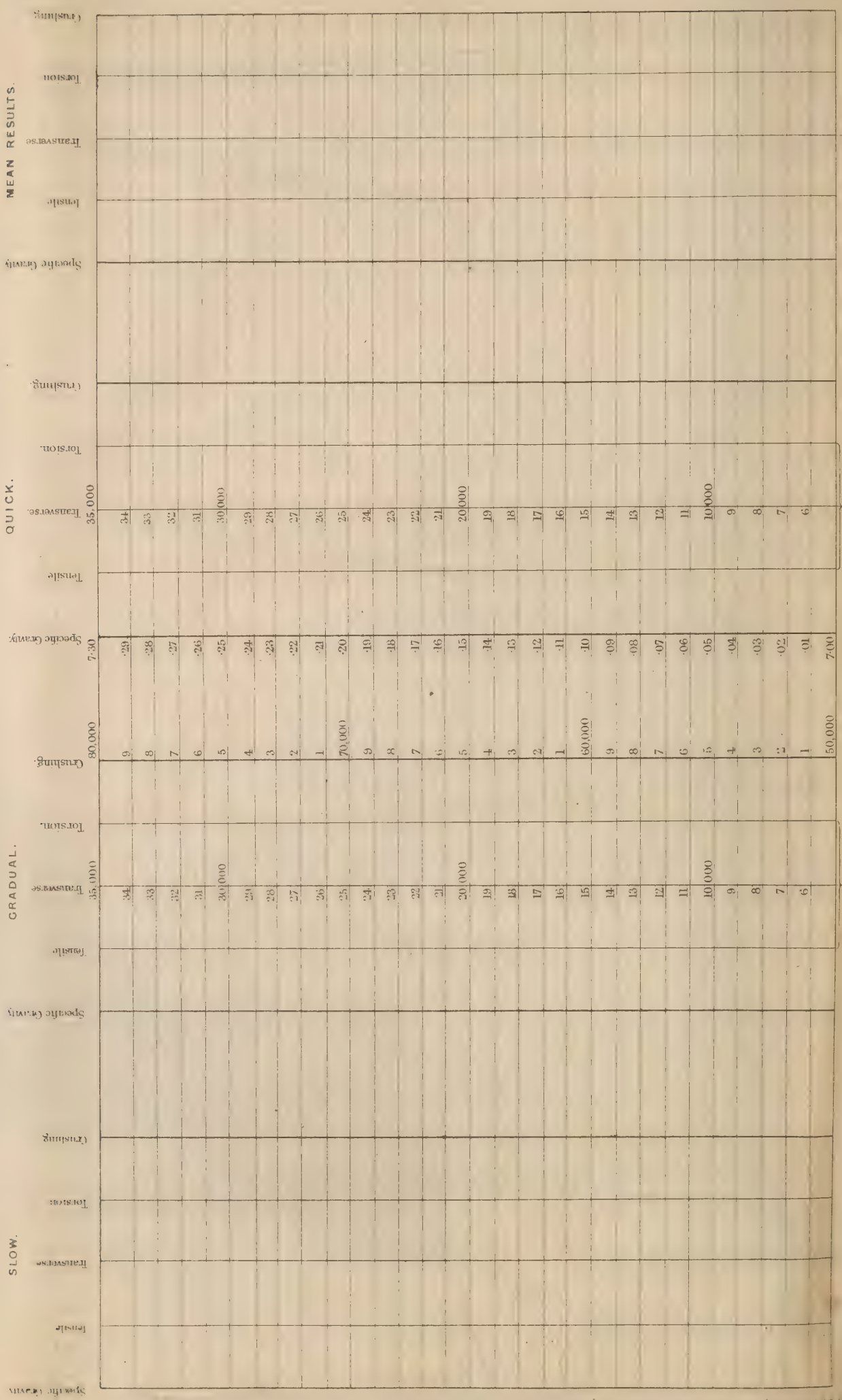
Hall, Brog. Litho. Castle St, Holborn.

Henry Hansard, Printer.

No. 20 1.

Messrs Cooper, Indian Iron Compy

PLATE No. 58.



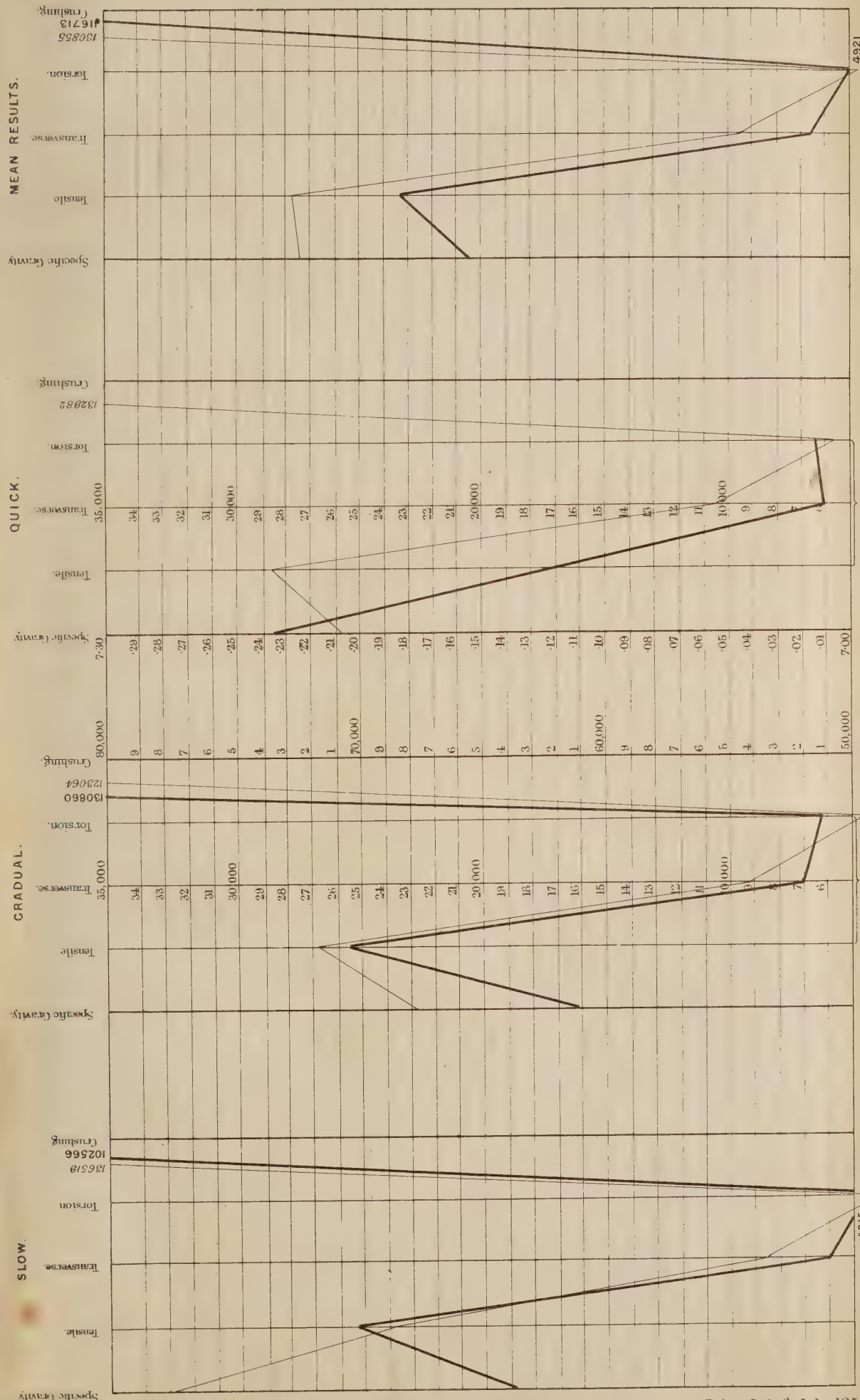
No. 497. Ordered, by The House of Commons, to be Printed, 30th July 1858

Hall Bros Litho Castle St. Holborn

Henry

No. 5 1. Butterley Iron Company, Mr. Low's Patent.

PLATE No. 59.



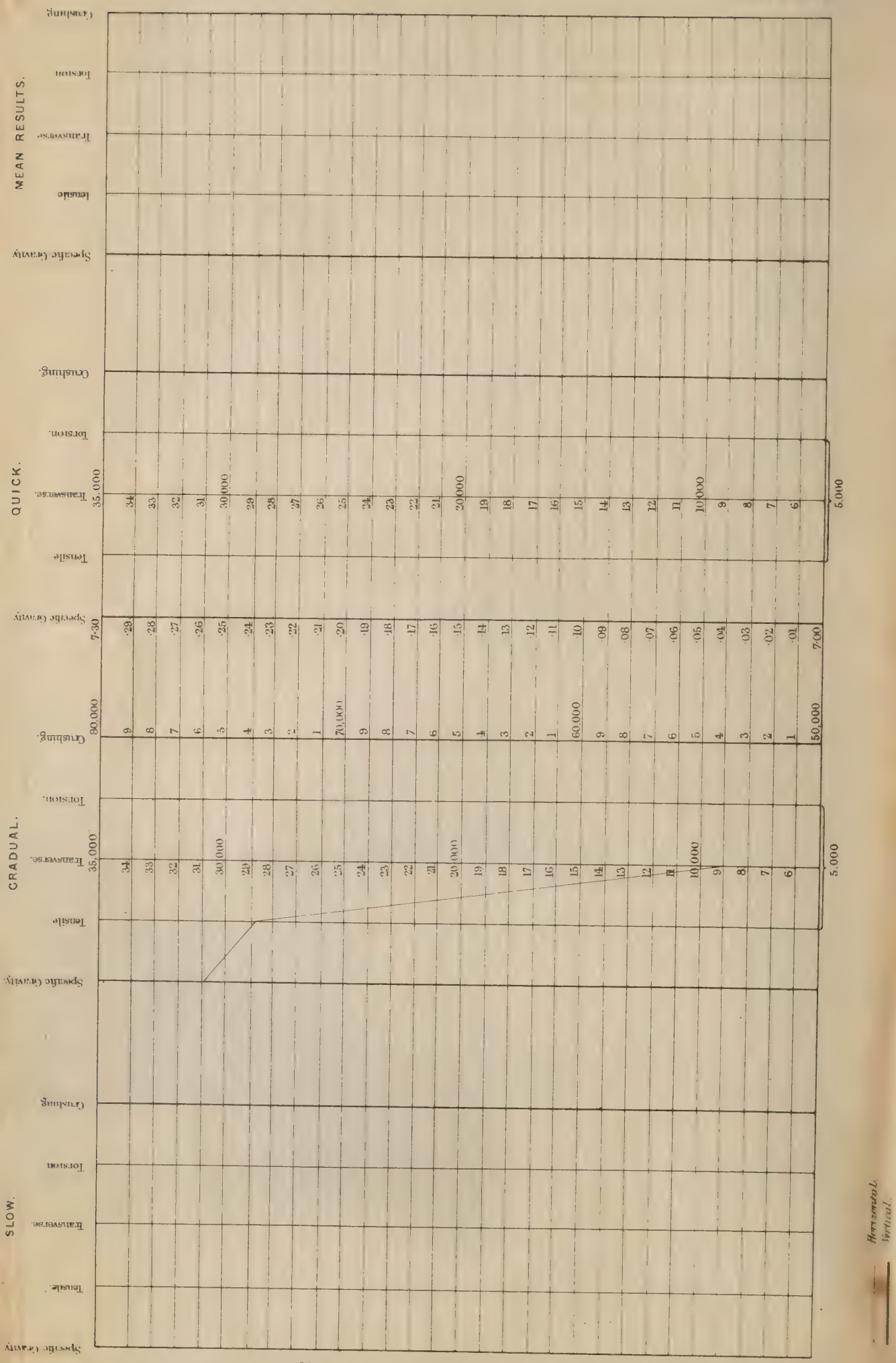
No. 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Henry Hansard, Printer

Hall Printer to the Castle St. Holborn

Nº MESSRS PRICE & NICHOLSON'S PATENT IRON.

PLATE Nº 60.



Nº 497. Ordered, by The House of Commons, to be Printed, 30th July, 1858.

Will. Brot. Johns Castle St. Holborn.

Henry Hansard, Printer.

BIBL. LONDIN. UNIV.

PAPERS.

CAST IRON EXPERIMENTS.

Ordered, by The House of Commons, *to be Printed,*
30 *July* 1858.

[*Price* 3 *s.* 8 *d.*]

497.

Under 2 *lbs.* 8 *oz.*